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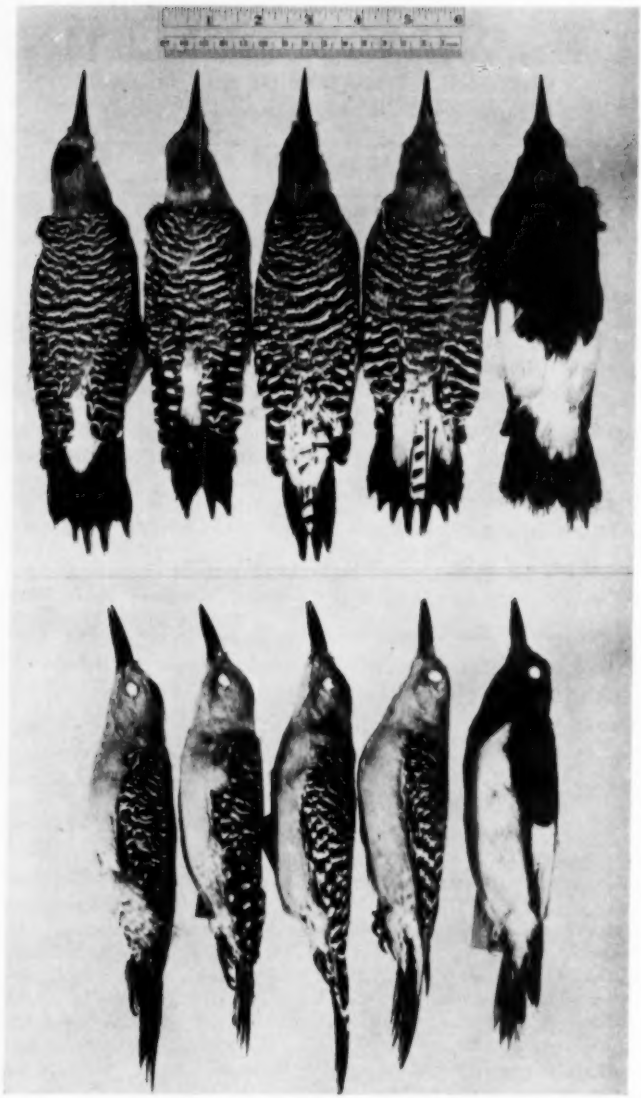

Specimens of woodpeckers from central Texas in dorsal (above) and lateral (below) view. From left to right, male and female *Centurus aurifrons*, male and female *C. carolinus*, and female *Melanerpes erythrocephalus*.

INTERSPECIFIC RELATIONS OF WOODPECKERS IN TEXAS

BY ROBERT K. SELANDER AND DONALD R. GILLER

CONCRETE information on ecologic relations of closely related species is infrequently reported, especially in this country. A small number of documented cases of interspecific territorialism in birds is known (see review by K. E. L. Simmons, 1951; also, Pitelka, 1951; Legg and Pitelka, 1956; Dixon, 1950, 1954), but many additional data will be needed before the full significance of this phenomenon, with respect to species' distribution, numbers, and evolution, can be evaluated.

This paper is a preliminary report of studies on territorial and other relations of three woodpeckers in the Austin region, central Texas. The subjects are the Red-bellied Woodpecker (*Centurus carolinus*), Golden-fronted Woodpecker (*Centurus aurifrons*), and Red-headed Woodpecker (*Melanerpes erythrocephalus*). The data herein reported were gathered, more or less irregularly, over a period extending from spring, 1957, to spring, 1958.

RELATIONS OF *C. carolinus* AND *C. aurifrons*

The following notes on the systematic and ecologic relations of *C. carolinus* and *C. aurifrons* are prompted in part by a recent suggestion (Brodkorb, 1957) that the two may be conspecific. This is not the case, as they are sympatric without interbreeding in central Texas.

Distribution.—Centurus carolinus ranges west to central Texas and is replaced in the west and in the Panhandle by *C. aurifrons*. Apparently nowhere is there extensive overlap in ranges, but at least locally in south-central Texas they are sympatric. At Austin, Travis County, overlap is limited to a zone not more than 20 miles in width, and the two species may regularly be seen together only within the limits of the city itself. We have little to add at this time to G. F. Simmons' detailed account (1925) of the local distribution of these woodpeckers in the Austin region, which includes all of Travis County and parts of adjacent counties. The reader is also referred to G. F. Simmons' book for accounts of physiography, climate, and vegetation of the region. Climatically, Austin is intermediate between semi-arid regions to the south and west and mesic regions to the east. There is a marked east-west faunal and floral "break" in the Austin region, discussed by Blair (1950). Contact and hybridization between the eastern Tufted Titmouse (*Parus bicolor bicolor*) and a black-crested race (*P. b. atricristatus*) occur in the same region in which ranges of the *Centurus* woodpeckers overlap (Dixon, 1955).

C. carolinus is common throughout Austin and in the region to the east, especially in forest and woodland on the floodplain of the Colorado River; but, rarely has it been recorded even a few miles west of the city. In Austin, *C. aurifrons* is comparatively uncommon and localized in distribution, but pairs

may regularly be found in several places in the southern and western parts of town, as at Barton Springs; and it occurs in small numbers in central and eastern Austin, as in the City Cemetery a few blocks east of the campus of the University of Texas. West and, especially, south of Austin it is moderately common. At San Antonio, 80 miles south-southwest of Austin, it is common, and there are no records of *carolinus* (Attwater, 1892:235).

Both species are permanent residents in the Austin region. There is probably an influx of *C. carolinus* from the north in the winter, at which time it is more common than in the summer in timber on the floodplain of the Colorado River. However, the local distribution of both species is, by and large, similar in all seasons.

Neither species appears to be in the process of extending its range in Texas. Even the local distribution and relative abundance of these species in the Austin region apparently have not changed to any great extent within the last 33 years. Many of the specific localities for *carolinus* and *aurifrons* mentioned by G. F. Simmons in 1925 are those in which the species are found at the present time. As the city of Austin continues to expand, a decrease in numbers of *aurifrons* may be expected as tracts of mesquite, juniper, and oak are cleared west and south of town.

Morphologic Differences between Species.—In central Texas both species of *Centurus* are closely similar in size (Table 1) and in general appearance (frontispiece). The only conspicuous difference is in the color and pattern of the head. In the male *C. carolinus* the entire dorsal surface of the head is red; in the male *C. aurifrons* the nasal region is yellow, the nape is golden yellow, and a coronal patch of red is surrounded by gray. In the female *carolinus* the nasal region and nape are red, whereas these are yellow in *aurifrons*. In females of both species the coronal region is gray. The abdominal region is washed with red in *carolinus*; the belly may or may not have a suffusion of yellowish in specimens from eastern parts of the state (Burleigh and Lowery, 1944). This region is washed with yellow or golden yellow in *aurifrons*. There are also some minor differences in pattern of the upper tail coverts and inner webs of the central rectrices (see frontispiece).

Both species very geographically in Texas. A series of *C. aurifrons* from the Texas Panhandle and Harmon County, Oklahoma, at the northern limit of the species' range, is considerably larger in all dimensions than birds from central and southern Texas. Specimens from Oklahoma have been referred to *C. a. incanescens* (A. O. U. Check-list, 1957:317), a race named from Brewster County, western Texas, and distinguished from *C. a. aurifrons* of southern Texas and México on the basis of minor color and pattern differences. However, specimens from Brewster County are small like those from central-southern Texas. Variation in size apparently was not considered by Wetmore

(1948) in his review of geographic variation in *Centurus aurifrons*, but it is apparent that there is a north-south cline in size in Texas, which may or may not be concordant with clines of variation in color and pattern.

TABLE 1

MEASUREMENTS (IN MM.) OF WOODPECKERS FROM TEXAS

	No.	Wing	Tail	Bill	Tarsus
		ADULT MALES			
C. aurifrons[1]	8	137.0 (132–140)	82.0 (76–85)	27.06 (24.9–28.8)	24.70 (24.0–26.0)
C. aurifrons[2]	8	129.7 (128–132)	77.1 (76–79)	25.80 (24.2–27.0)	22.20 (20.2–23.2)
C. carolinus[3]	6	129.0 (126–132)	76.4 (70–80)	24.35 (23.2–25.3)	21.22 (19.7–21.8)
M. erythrocephalus	3	140.0 (137–143)	80.0 (78–82)	22.93 (22.1–24.0)	22.10 (21.9–22.3)
		ADULT FEMALES			
C. aurifrons[1]	1	134	80	27.6	23.2
C. aurifrons[2]	6	127.8 (125–132)	73.7 (69–77)	23.48 (22.2–25.1)	22.53 (21.7–23.7)
C. carolinus[3]	4	125.7 (124–128)	73.3 (70–76)	23.30 (22.2–25.3)	19.90 (19.4–20.5)
M. erythrocephalus	1	141	72	22.5	22.8

[1] Texas Panhandle and Harmon Co., Oklahoma.
[2] Central–southern Texas from Travis County south.
[3] Central Texas from Travis County east to Anderson County.

Specimens of *C. carolinus* from Austin and Houston southward reportedly are paler than those from northeastern Texas and have been distinguished racially, as *C. a. harpaceus*, by Koelz (1954).

Habitat Occurrence.—Throughout its range in Texas, and also extensively in northern México, *C. aurifrons* inhabits xeric vegetation types in which mesquite is often a dominant element. At Uvalde, Uvalde County, and at Pearsall, Frio County, *aurifrons* is a common resident in mesquite woodland. In Palo Duro Canyon, northern Texas, it occurs in riparian cottonwoods and mesquite flats on the floodplain of the Prairie Dog Town Fork of the Red River. Characteristic habitat of this species south and north of Austin is a mixed oak, large mesquite, and juniper formation on gravel ridges extending from the Balcones escarpment for several miles into the black prairie soils east of Austin (see Dixon, 1955, Fig. 9 and p. 169). We have one record of *aurifrons* in this vegetation five miles east of Austin. In this formation *carolinus* is rarely found.

C. aurifrons also frequents pecan groves and other open situations on floodplains, and in small numbers it is found in live oaks, elms, and other mesic types in residential districts in Austin, especially where these are adjacent to stands of mesquite, deciduous oak, and juniper.

C. carolinus, in contrast, inhabits mesic formations, frequenting "dead trees, preferably in heavily timbered bottom lands or swampy woods; open deciduous or mixed coniferous woodlands with very large trees [including pecan groves]; heavy woods of oak and elm along rivers and creek bottoms; shade trees and dead trees in town" (G. F. Simmons, 1925:133).

The marked difference between the species in habitat occurrence functions in the overlap zone to limit contact and, at the same time, competition between them. It should be emphasized that these ecologic differences are shown elsewhere than in the zone of overlap. There is no conspicuous narrowing of habitat range in the Austin region. The overlap in habitat occurrence is sufficiently extensive, however, to warrant the hypothesis that either species would, in the absence of the other, occur in greater density in the overlap zone. Considering the fact that populations of *aurifrons* have managed to adapt to mesic and humid habitats in México, it is perhaps surprising that the distribution of the Texas population stops abruptly in the Austin region, unless, of course, the presence of *carolinus* prevents further extension of range.

Behavioral Differences.—The two woodpeckers are much alike in behavior, as far as we have determined. *C. aurifrons* is warier than *C. carolinus* and therefore less easily approached and observed; it is decidedly more shy in the vicinity of its nest. Foraging habits seem to be identical in the two species. In the Austin region their breeding seasons coincide (G. F. Simmons, 1925).

The vocalizations are described by G. F. Simmons (*op. cit.*). Both species have the same repertoire of calls, but those of *aurifrons* are louder and harsher, and on this account easily recognized. The pulsed "location" call, used primarily to "advertise" territory in the breeding season, and the common warning *cha* note of the two species are compared in Fig. 1; other calls are equally similar. The "location" call of *aurifrons* is less precisely tuned and slightly higher-pitched than that of *carolinus*, and it ends less abruptly.

Lack of Interbreeding.—Considering the ecologic and morphologic similarities of *C. carolinus* and *C. aurifrons*, it is indeed surprising that they do not at least occasionally interbreed. However, in the past two years we have carefully noted the composition of dozens of pairs, and, invariably, the members have been of the same species. Moreover, we have seen no individual evidencing mixed ancestry, although, of course, hybridization in these morphologically similar species might be difficult to detect. The possibility that the color and pattern differences are controlled by a unifactorial genetic mechanism has been considered. If this were the case, interbreeding could occur without intergradation of characters in the hybrids; but it seems unlikely that this same mechanism would control voice and behavioral differences as well. Some specimens of *aurifrons* have one or more red or orange feathers in the nape, but this does not necessarily indicate hybridization. The same character occurs in many (perhaps all) yellow-naped populations of *aurifrons* and is no more marked or frequent in specimens from Travis County than in those from western Texas and northern México.

To sum up, we have found no evidence of cross-pairing or hybridization between members of the two populations, but the nature of the reproductive iso-

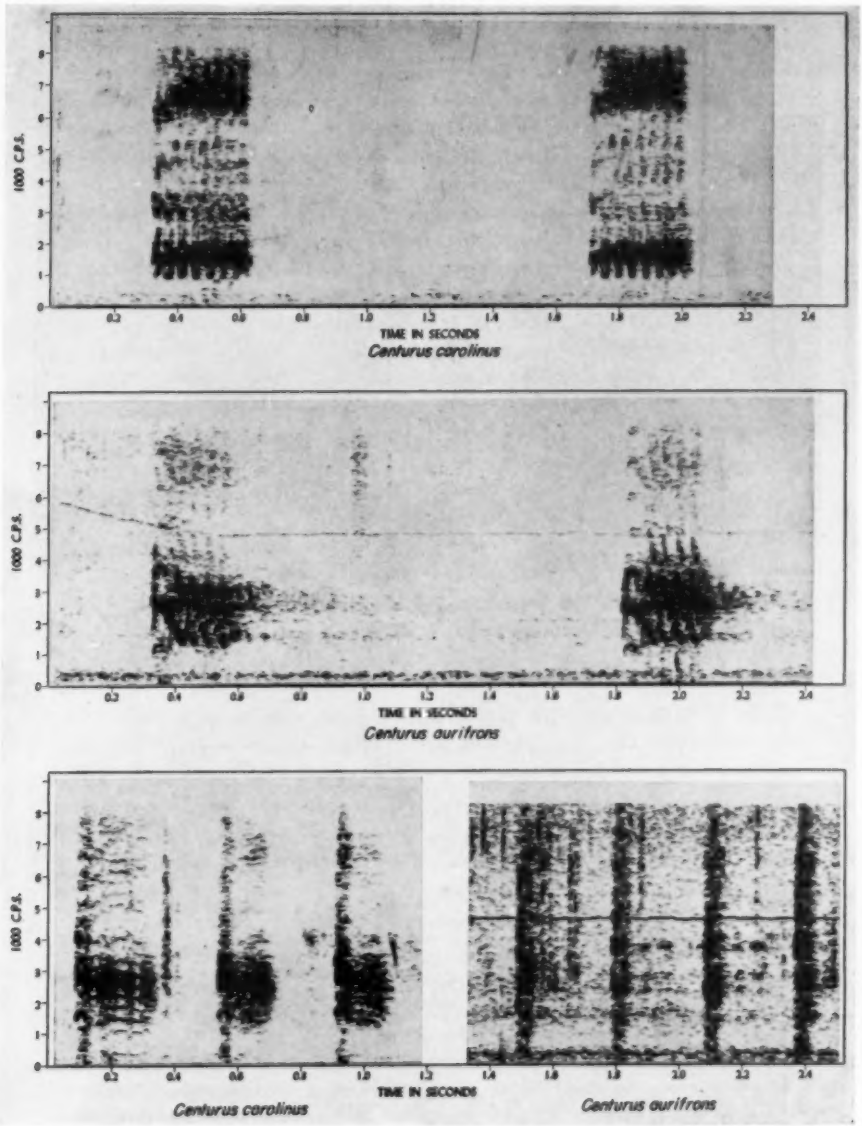

FIG. 1. Sound spectrographs of calls of male **Centurus** woodpeckers from central Texas. Above, "location" calls; below, warning calls. Intensity of markings is proportional to energy involved at the frequency level. (The thin line near 5000 c.p.s. in the graphs of **C. aurifrons** calls results from a signal in the tape recorder itself.)

lating mechanism remains to be determined. Differences in vocalizations seem hardly great enough to function alone as an effective isolating mechanism. At present practically no information concerning sexual behavior in these species, or, for that matter, in any other species of the genus, is available. A thorough study of courtship and mating behavior is indicated, but this might be a difficult undertaking. It appears that in both species many birds remain paired throughout the year. G. F. Simmons (1925:133) notes that *carolinus* "frequently spends the winter about trees where it will nest the following spring. . . ." It is possible that pair bonds are maintained for several years or for life. If so, opportunity to study the critical stage of pair formation will be limited.

It may be noted in passing that these facts bear on the problem of reproductive isolation, since the probability of the occurrence of a "mistake" in pairing, leading to hybridization, depends on the absolute number of pair bonds formed. In species in which pairing occurs each spring, opportunities for "mistakes" are obvously greater than in species in which a bird pairs only once or a few times in its life. Moreover, the formation of lasting pair bonds is usually preceded by long courtship or "engagement" periods, which also tend to reduce the chances for hybridization (Mayr, 1942).

Territorial Relations.—Observations by one of us (Selander) on the general spatial relations of the two species and of several interspecific conflicts in 1956 suggested that they held mutually exclusive territories. Subsequent observations confirmed this suspicion, and in the spring of 1957 the territorial relations of two pairs were studied in some detail.

The study area was at the Deep Eddy housing project of the University of Texas in western Austin (Fig. 2). Observations were made almost daily from March 25 to May 11, 1957, and occasionally thereafter through May, 1958. Movements of the woodpeckers were plotted on maps, and the records are summarized in Fig. 3.

The pair of *C. carolinus* nested in a chinaberry tree approximately 75 yards from a deciduous oak tree in which the pair of *C. aurifrons* nested. Both nests were about 15 feet above the ground. The territories of both species extended well beyond the limits of the area shown in Fig. 3.

As observations of movements accumulated, it soon became apparent that a rigid, sharply defined line of division was maintained between territories of the two species. No tree in the study area was frequented at the same time by both species without conflict. Even in the absence of their neighbors, the pairs were reluctant to cross the territorial boundary.

The territorial boundary was well established when our study began, and conflicts were infrequently seen. On March 28, the male *aurifrons* penetrated the *carolinus* territory to point "A" in Fig. 3; immediately he was attacked by the male *carolinus* and driven back to his territory. Again, on April 6, the male *aurifrons* entered the other species' territory.

FIG. 2. Above: View of territory of *C. carolinus* at Deep Eddy study area, taken facing north from position "A" in Fig. 3. Below: Study area at Walker Ranch. Nest-tree of *M. erythrocephalus* is just left of large mesquite; that of *C. carolinus* is on the far right.

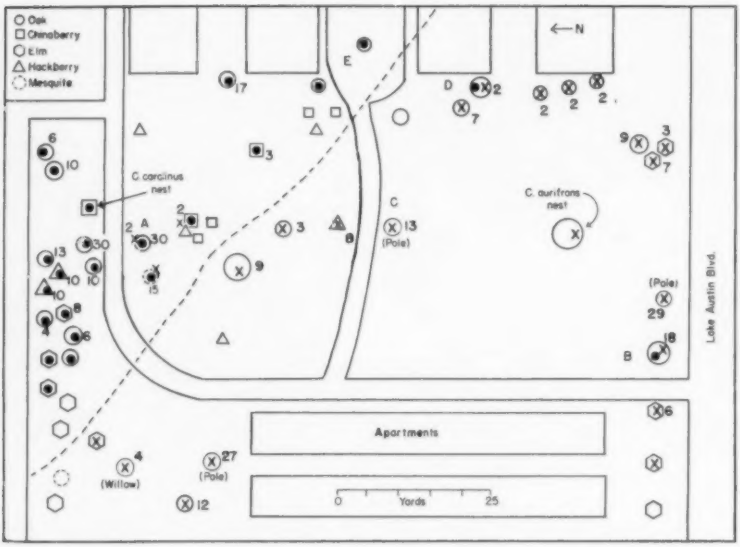

FIG. 3. Study area at Deep Eddy housing project, Austin, showing interspecific territorialism in *Centurus*. X's indicate records of *C. aurifrons*; dots represent records of *C. carolinus*; where there is more than one record for a location, the number is indicated. The territorial boundary is indicated by the dashed line.

The two males fought in three different trees near point "A," and the *aurifrons* finally retreated to his territory, flying to the nest-tree.

On April 25, the female *aurifrons* entered *carolinus* territory. This time the female *carolinus* responded, a fight ensued, and the female *carolinus* chased the female *aurifrons* back across the territorial boundary.

C. carolinus less frequently trespassed on *C. aurifrons* territory. On May 11, however, the male *carolinus* flew very near to the ground from his nest-tree to the tree at position "B." It "hid" behind the tree for two minutes, peeked around one side or the other at the nest-tree of *aurifrons*, then flew toward the *aurifrons* nest-tree, where the male and female were perched. Both the male and female *aurifrons* attacked the male *carolinus* as he flew toward the tree. The female soon returned to the nest-tree, but the male continued to attack, driving the male *carolinus* to position "C," at which point he circled back and returned to the nest-tree. The retreating male *carolinus* continued on to his own nest-tree.

On March 29, the male *carolinus* entered *aurifrons* territory, where he fought with another male *carolinus* at position "D," and again within his own territory at position "E." The latter individual held a territory east of the study area. The pair of *aurifrons* was foraging off the study area at the time of this invasion.

Displays and calls used in interspecific territorial defense did not differ in any way from those employed in intraspecific encounters of the same type.

In the spring of 1958, the territory of the pair of *aurifrons* at Deep Eddy was

expanded to include that part of the territory of *carolinus* shown in Fig. 3. On April 19, the two males engaged in a vigorous fight in the *carolinus* nest-tree, following which *carolinus* retreated from the area. Subsequently, the pair of *aurifrons* raised a brood in the same hole used by *carolinus* in the previous year.

Relations of *C. carolinus* and *M. erythrocephalus*

In April, 1958, an unexpected opportunity to study ecologic relations of *C. carolinus* and a third species of similar size (Table 1), *Melanerpes erythrocephalus*, was provided. This woodpecker, like *C. carolinus*, with which it is sympatric in southeastern Canada and the eastern United States, reaches its southwestern distributional limit in central Texas at Austin. Formerly a fairly common summer resident in the Austin region (G. F. Simmons, 1925:131), it is now rare. There have been no more than a half-dozen records of this species in Travis County in the last 10 years. It is possible that withdrawal of *M. erythrocephalus* from central Texas was related to the long drought that ended in the spring of 1957 (Blair, 1958). Now that environmental conditions are again "normal" in this region, it will be interesting to see if it returns in any numbers.

On April 17, we were directed by Mr. Wyle Hord to the territory of a pair of *erythrocephalus* on the Walker Ranch, along the Colorado River about two miles east of Austin (Fig. 4). According to Mr. Hord, the pair was first seen by him in the spring of 1957. The birds nested successfully in 1957 and wintered there in 1957–58. A fledgling was seen near the nest-hole on August 7 by Mr. Fred S. Webster and Dr. C. H. Brownlee. Webster, who has been one of the most active observers in the central Texas region for the past six years, informs us that this is the only breeding record of this woodpecker in the Austin region that has come to his attention. He suspects, however, that a few additional pairs may be found along the Colorado River between Austin and Bastrop. Occasionally, lone birds have been seen in winter along Onion Creek, a few miles southeast of Austin, and along the Colorado River.

Fortunately, a nesting pair of *carolinus* was located in the same area, permitting study of the territorial relations of the two species (Fig. 4). Observations were made at the Walker Ranch from April 17 to 23 and on May 1.

Activities of the *erythrocephalus* centered about a small, dead cottonwood tree adjacent to a small corral and a mesquite tree in a grassy meadow (Fig. 2). Several holes had been drilled in the cottonwood, including one "active" hole about 15 feet above the ground which the birds occasionally entered and in which at least one roosted at night. They were not incubating at the time of our study, but we saw some courtship behavior and it was obvious that they were preparing to breed; copulation was noted on May 1. On the same day a third individual of *erythrocephalus* appeared and was attacked and driven from the territory by the pair. Apparently this species breeds somewhat later, on the average, than does *C. carolinus* (Bent, 1939).

Movements of the birds were recorded and mapped (Fig. 4) over a period of about eight hours on three different days. The birds often visited the nest-tree and also spent a good deal of time in the adjacent grove of tall cottonwoods, to which they almost invariably retreated as we approached the nest-tree. They also visited cottonwoods and hackberry trees along the river; and on April 18 the pair fed for one-half hour in a large cottonwood

only 25 yards from the nest of *carolinus*. The pair of the latter species nested in a dead limb of a cottonwood which was larger than that used by *erythrocephalus*. The nest-hole was 15 feet above the ground, and the opening faced north. The nests of the two species were 80 yards apart.

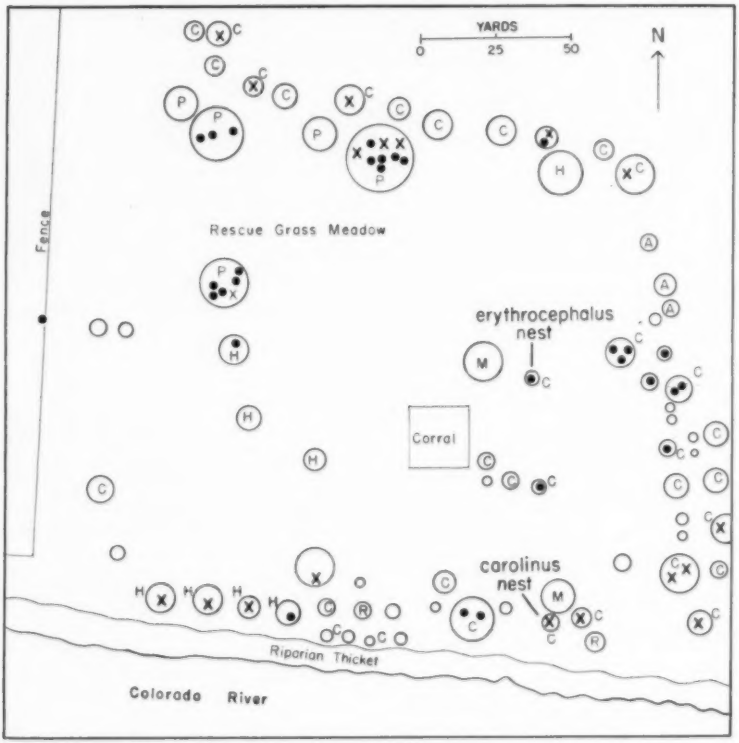

FIG. 4. Study area at Walker Ranch, showing overlap in territories of *C. carolinus* and *M. erythrocephalus*. X's indicate records of *carolinus*; dots represent records of *erythrocephalus*. Letters identify trees, as follows: A, ash; C, cottonwood; H, hackberry; M, mesquite; P, pecan; R, retama.

The pair members of *carolinus* were feeding young, making repeated visits to the nest with insects. They foraged over a much larger area than did the *erythrocephalus*. It will be seen in Fig. 4 that *carolinus* visited the large pecan tree to the north of the *erythrocephalus* nest-tree and also the southern part of the grove of cottonwoods and a line of hackberry trees along the river. Sometimes they flew south across the river to forage in trees located several hundred yards from their nest. On three occasions the male *carolinus* passed within a few feet of the nest-tree of the other species, while one or both of the latter were present,

but no interspecific conflict was seen. We noted, however, that *carolinus* did not forage in the grove of cottonwoods east of the *erythrocephalus* nest-tree, although several times they flew through the grove on their way to forage in trees beyond the study area to the north.

In summary, it seemed evident even from our limited series of observations that the territorial relations of *C. carolinus* and *M. erythrocephalus* were decidedly different from those of the former species and *C. aurifrons*. Their territories overlapped broadly and no interspecific conflict was noted.

Experiments with Dummies.—In an attempt to investigate factors involved in species recognition, we have performed a series of experiments in which dummy woodpeckers (study skins) were placed at various points in the territories of pairs of woodpeckers and the ensuing responses recorded. Not all of these throw light on the problem of interspecific territorialism, but they are none the less of some interest.

On May 8, 1957, a male dummy *C. aurifrons* was wired to a limb one foot below the nest-hole of the pair of *C. carolinus* that was being studied at Deep Eddy. Immediately the female *carolinus* attacked the dummy, striking it repeatedly with her bill for a period of 45 minutes. The great majority of her blows were directed at the head, particularly the eye region. Her attack stopped only when we approached the tree to retrieve the dummy, which was by then all but torn to pieces. The male made only a few passes at the dummy and left the tree a few minutes after it was placed in position.

The next day, May 9, we attached both male and female dummies of *carolinus* to the nest-tree of the pair of *aurifrons*, placing them within two or three feet of the nest-hole. At once both male and female *aurifrons* attacked the dummies, with the first blows being directed male to male and female to female. In this particular case, the male was much more aggressive than the female. The latter seemed apprehensive and alternately pecked at the dummy and retreated. After 15 minutes the head of the male dummy was detached and fell to the ground. Nonetheless, the male continued his attack on the headless dummy for another five minutes and then directed his response toward the female dummy; but he continued to make occasional passes at the headless dummy. Again the majority of blows were directed at the dummies' heads.

Ten minutes after the head was knocked from the male dummy, both dummies were removed from the nest-tree and placed on a telephone pole 40 yards from the nest-tree. The dummies were attacked in their new positions, but with lessened intensity, and the attacks were not so long sustained. The same type of experiment was performed by placing a dummy male *aurifrons* on a post within the territory of the *carolinus*. As in the previous experiment, the dummy was attacked with less intensity than when it was placed on the nest-tree.

The results of our work with dummies were not unexpected in view of our previous observations on territorial behavior. Subsequent tests with other pairs of *carolinus* have shown that the female of this species takes a more active part in defense of the nest-hole area against the dummies than does the male. The same pattern of behavior may be seen when one approaches the nest-tree of a pair of *carolinus* in which eggs or young are present. The female usually remains in the nest-tree calling excitedly, whereas the male almost invariably flies to a distant tree, returning only when the intruder has departed.

A second test with *aurifrons* also confirmed our first, to the effect that in this species the male is more aggressive in encounters at the nest-hole than is the female; but additional testing is needed.

The fact that attacks were usually directed at the heads of the dummies suggested that this part of the body alone supplies at least the important sign stimuli releasing aggressive behavior. This was confirmed by wiring the head of a dummy female *carolinus* two feet above the nest-hole of a pair of *carolinus* in a mesquite tree on the University of Texas campus on April 6, 1958. The female came to the nest-tree, suddenly flew to an adjacent stand of cottonwoods, and returned in company with the male. The male flew to the head and pecked it violently (Fig. 5), and the female soon joined him in the attack. After about 10 minutes, the forepart of the dummy's head, including the bill, came loose, and the male flew off with it in his bill. To our surprise, the female continued her attack on the remnants of the head, a ball of cotton used to stuff the dummy and a tuft of red feathers on the coronal and occipital regions. Her attack continued for several minutes but ceased abruptly when her blows dislodged the few remaining feathers. Shortly thereafter, the male returned and investigated the "remains"; then he entered the nest-hole, presumably to incubate, and the female foraged in the nest-tree. These observations suggest that the red feathers of the head are of paramount importance in releasing aggressive behavior. We have not pursued the problem further, but it is clear that the response to the head alone is fully as strong as to the entire dummy.

Despite the fact that the pair of *M. erythrocephalus* did not behave aggressively toward *C. carolinus*, even when the male of the latter species flew within a few feet of their nest-tree, they readily attacked dummies of that species placed near their nest-hole (Fig. 6). When presented simultaneously with dummies of *carolinus* and their own species, they usually directed their initial attack at the latter, but the defense of the nest-tree against the *carolinus* dummy was vigorous. These tests help account for the fact that the pair of *carolinus* avoided perching in the vicinity of the nest-tree of *erythrocephalus*.

Discussion

In a recent review of interspecific territorialism in birds, K. E. L. Simmons (1951:407) has suggested that the term be confined to cases in which "a territory holder of one species exhibits persistent aggressive behaviour to an intruding bird of a second species, showing to it some, if not all, of the reactions usually forthcoming in intraspecific encounters." Further, he suggests that the aggression should be related to the territory as a whole and not merely to a particular part of it, thus excluding contests between hole-nesters at nest-sites. We are in general agreement with Simmons in this regard. Conflicts between hole-nesting species competing for roosting or nesting sites frequently involve

FIG. 5. Male *C. carolinus* attacking head of male dummy *C. carolinus* near nest-hole.

species which do not hold exclusive territories. The relations of *C. aurifrons* and *C. carolinus*, however, satisfy all criteria for interspecific territorialism. The case is unusual in that the territories are mutually exclusive; in their ter-

ritorial relations, the two woodpeckers behave as if they were a single-species population.

Where the two species of *Centurus* occur together, competition for space and nesting sites is manifested in interspecific territorialism. Lack of significant differences in feeding and nesting habits and in timing of events of the annual cycle would seem to preclude the possibility of their coexistence, except in a narrow contact zone where there is complex inter-digitation of vegetation types. Reproductive isolation is complete, but the species have so far failed to evolve ecologic adjustments that would permit extensive sympatry.

In the case of *Centurus carolinus* and *Melanerpes erythrocephalus*, sympatry is possible because the necessary ecologic adjustments have been made, and it appears that they do not show interspecific territorialism. There are obvious differences between these species in foraging habits and habitat occurrence. Our observations show that *erythrocephalus* feeds regularly not in the manner of "typical" woodpeckers but by "flycatching." The relatively longer wing and tail of this species (Table 1) may be related to this trait, which has also been noted by several other writers, including G. F. Simmons (1925:132), Skinner (*fide* Bent, 1939:201), and Nauman (1930). Studies of stomach contents by Beal (1911) reflect differences in foraging habits in the two woodpeckers. He notes that *erythrocephalus* "eats very few beetle larvae or other grubs, or ants that live in wood or other places of concealment. Apparently it is not so fond of pecking wood as are the other species [of woodpeckers] . . . ." In our experience, *carolinus* "flycatches" only occasionally, and all lines of evidence point to the conclusion that *erythrocephalus* obtains significantly less of its food by foraging over trunks, branches, and leaves than does the other species. In the course of our studies in April, we rarely saw *erythrocephalus* dig or probe into bark, whereas *carolinus* fed almost exclusively in this fashion. Typically, *erythrocephalus* fed by perching in exposed positions atop large pecan or cottonwood trees and darting out some 20 to 40 yards to catch large flying insects, some of which were beetles. We watched one or both individuals repeat this action for periods of up to an hour, and Nauman (1930) calculated that one bird, which was feeding a fledgling, made five to seven sallies per minute, catching a calculated 600 flying insects in the course of an hour. Between sallies, the birds often perch crosswise in the manner of passerines, and the head is turned from side to side as they peer about for insects. Some insects are swallowed immediately after a bird returns to its "lookout" perch, but larger ones are usually wedged in crevices (typically in stumps), smashed, and picked apart.

This discussion is not intended to suggest that *erythrocephalus* feeds exclusively in this manner. The species also drills into wood and, especially in the fall and winter, feeds on beechnuts, berries, acorns, seeds, and other vege-

FIG. 6. *M. erythrocephalus* attacking male dummies of its own species (above) and *C. carolinus* (below).

table food (Beal, 1911); in addition, it reportedly (Bent, 1939:199) takes both eggs and young of some small passerines.

The fact that *erythrocephalus* tends to frequent more open situations than does *carolinus* may be related to differences in feeding habits. In any event, it is probably important in permitting the two species to coexist. Bent (1939: 195) regarded *erythrocephalus* as "essentially a bird of open country and not in any sense a forest dweller," and other naturalists quoted by Bent have noted its preference for open groves, "old burns," and other similar situations. Our observations and those of G. F. Simmons (1925:131) in Texas agree fully with these reports. Simmons noted the preference of *erythrocephalus* for edges of woodlands, orchards, groves, and clearings in open woods, and that of *carolinus* for heavily wooded bottomlands. At the Engeling Wildlife Management Area, Anderson County, Texas, in November, 1956, we found *erythrocephalus* somewhat less numerous than *carolinus* and confined to a partly burned stand of trees bordering a meadow, whereas *carolinus* was generally distributed throughout the oak forest. Even in the study area at Walker Ranch, a preference of *erythrocephalus* for open situations was apparent, as evidenced, for example, by the location of the nests of the two species (see Fig. 4).

Since the foregoing was written, Kilham (1958a, 1958b, and 1958c) has published three important articles dealing with the biology of *C. carolinus* and *M. erythrocephalus* in Maryland. Among his significant findings are the following: Pairs of *C. carolinus* disband in late summer, and nesting, which begins in April, is preceded by a long period of courtship and pair bond reinforcement beginning in January. Individuals of *M. erythrocephalus* holding small winter territories in woodland defended their areas and acorn stores against *C. carolinus* and a variety of other species of birds.

Summary

Interspecific relations of three woodpeckers of approximately equal size were studied in central Texas. The closely related, morphologically similar Red-bellied Woodpecker (*Centurus carolinus*) and Golden-fronted Woodpecker (*Centurus aurifrons*) are sympatric in a narrow zone in the Austin region. Within this overlap zone, differences in habitat occurrence limit contact and competition; but both species occur in the city of Austin, where they hold mutually exclusive territories. Feeding and nesting habits are similar in the two species, as are vocalizations and displays. Reproductive isolating mechanisms, the nature of which are unknown, have evolved, but the species have not made ecologic adjustments which would permit extensive sympatry.

The territorial relations of a pair of *C. carolinus* and a pair of Red-headed Woodpeckers (*Melanerpes erythrocephalus*) were studied. Their territories overlapped broadly, and interspecific antagonism was not observed. It is suggested that differences in foraging habits and habitat occurrence are important factors permitting extensive sympatry of these species.

The reactions of nesting woodpeckers to dummies were tested. Both *carolinus* and *aurifrons* attacked dummies of their own or of other species placed in their nest-trees or elsewhere in their territories. The head of a *carolinus* dummy was as effective in releasing aggressive behavior in *carolinus* as was the entire dummy. Dummies of *carolinus* and *erythrocephalus* placed near the nest-hole of *erythrocephalus* were attacked with approximately equal vigor.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF TEXAS, AUSTIN, TEXAS, MAY 26, 1958

THE UTILIZED TERRITORY OF THE OVENBIRD

BY JUDITH STENGER AND J. BRUCE FALLS

HANN (1937) showed that the Ovenbird (*Seiurus aurocapillus*) strongly exhibits territorial behavior. Since the area defended by the male is used for mating, nesting, and as a feeding ground for adults and young, it exemplifies type A of Nice's (1941) classification.

We studied territories of Ovenbirds in four forest types at the Wildlife Research Station of the Ontario Department of Lands and Forests, in Algonquin Park, Ontario. Observations were carried out during the summers of 1955 and 1956. This paper deals with the extent of the area utilized by a male Ovenbird during the breeding season, some aspects of the way in which it is utilized, and the variations in size which occur in this area as the breeding season progresses.

Description of Study Areas

Five plots for the study of territories of Ovenbirds were established in four forest types as follows: one plot in aspen, one in a conifer–birch association, two in a mixed hardwood–conifer association, and one in mature maple forest. One of the mixed plots was used only in 1955, and was so similar to the other that it will not be described in detail. The conifer–birch plot was used only in 1956. Each plot was surveyed into a grid of 66-foot squares and the intersections were marked. Areas of plots used varied from eight to 20 acres.

Differences in tree species and differences in number, height, and density of canopy layers were used to map study plots into cover types by inspection. Within each cover type circular areas of 33-foot radius were chosen arbitrarily. These samples, which included from eight to 16 per cent of the area in each plot, were used to estimate height, density (percentage of sky obstructed by foliage, not allowing for spaces between leaves), and species composition of each stratum of the forest. In addition, species and diameter at breast height (DBH) of all trees more than 1.5 inches in diameter were recorded.

Millacre quadrats (6.6 feet square) located at the grid intersections were used to estimate percentage of ground covered by logs and rocks, and by each species in the low vegetation.

Brief descriptions of the four main study plots are given below. The percentage of trees in the canopy made up by each of the commoner species is included.

Aspen Plot.—Upper canopy 93 per cent aspen (*Populus tremuloides, P. grandidentata*). Lower canopy 37 per cent maple (mainly *Acer rubrum*), 28 per cent white spruce (*Picea glauca*), and 23 per cent balsam fir (*Abies balsamea*). Brush layer denser than in other plots and composed mainly of hazel (*Corylus cornuta*) and small conifers. Common ground plants—bunchberry (*Cornus canadensis*), bracken (*Pteridium aquilinum*), and sarsaparilla (*Aralia nudicaulis*). Leaf litter mainly of broad leaves.

Conifer–birch Plot.—Upper canopy 39 per cent white birch (*Betula papyrifera*), 20 per cent aspen, and 32 per cent white pine (*Pinus strobus*). Lower canopy 71 per cent balsam fir. Brush of hazel and small conifers. Common ground plants—bracken, bunchberry, sarsaparilla, blueberry (*Vaccinium angustifolium, V. myrtilloides*), and grasses. Leaf litter mainly of pine needles.

Mixed Plot.—Variable. Parts resemble all other plots. Large areas of mature hardwood and other areas of pure conifer. Upper canopy 37 per cent white birch, 23 per cent red and sugar maples (*Acer rubrum, A. saccharum*), and 13 per cent white spruce. A few large specimens of yellow birch (*Betula lutea*), white pine, and hemlock (*Tsuga canadensis*). Lower canopy, present in only 34 of 42 samples, mainly of balsam fir (36 per cent), maples (20 per cent), white spruce (19 per cent), and white birch (12 per cent). Brush layer, present in only half the samples, chiefly of hazel, striped maple (*Acer pennsylvanicum*), and small conifers. Common ground plants—bunchberry, bracken, sarsaparilla, maple seedlings, dewberry (*Rubus pubescens*), and grasses.

Maple Plot.—Most complex canopy of any plot, having three layers all dominated by sugar maple, 85 per cent in upper and lower canopy, and 91 per cent of understory. Beech (*Fagus grandifolia*), 12 per cent of upper canopy. Some ironwood (*Ostrya virginiana*) in all three canopy layers. Lower canopy and understory present in 10 and 12 out of 17 samples, respectively. Brush present in only three of 17 samples, chiefly of striped and sugar maples. Ground vegetation mainly of tree seedlings—sugar maple, striped maple, and beech. More logs and deeper leaf litter than in other plots.

Table 1 shows the height and density of each stratum of the forest in each of these plots. Table 2 shows the composition of the forest. Trees are classified with regard to tolerance (here taken to mean capacity to develop and grow in the shade of and in competition with other trees) following Toumey and Korstian (1947).

When study plots are arranged in the order—Aspen, Conifer–birch, Mixed,

TABLE 1

HEIGHT AND DENSITY OF EACH STRATUM OF FOREST IN STUDY PLOTS

Strata	Plots			
	Aspen	Conifer–birch	Mixed	Maple
Height (feet)[1]				
Upper canopy	45	50	55	85
Lower canopy	25	25	25	35
Understory	—	—	—	17
Brush	8	5	6	4
Ground vegetation	1.5	1.5	1.5	1
Density (per cent covered)[1]				
Upper canopy	50	45	65	75
Lower canopy	20	15	20	85
Understory	—	—	—	40
Brush	50	30	25	25
Ground vegetation	70	70	45	5
Logs and rocks	5	5	10	10

[1] Median values are used for height and density.

TABLE 2

COMPOSITION OF FOREST IN STUDY PLOTS

Species[1]	Trees[2] per acre				Saplings[3] per acre			
	Aspen	Conifer–birch	Mixed	Maple	Aspen	Conifer–birch	Mixed	Maple
Tolerant								
Sugar and red maple	70	0	46	182	71	0	10	83
Striped maple	0	0	2	5	0	0	7	6
Ironwood	3	0	3	13	0	0	1	17
Beech	0	0	0	19	0	0	0	1
Balsam fir	53	141	58	0	39	79	21	0
Spruce (mainly white)	69	28	43	0	37	8	6	0
Hemlock	0	0	9	5	0	0	0	0
Intermediate								
Yellow birch	0	0	10	0	0	0	0	0
Pine (mainly white)	1	66	20	0	0	2	1	0
Intolerant								
Aspen (mainly trembling)	378	40	2	0	25	0	0	0
White birch	10	80	64	0	9	2	2	0
Willow sp.	0	0	0	0	7	0	0	0
Totals	584	355	257	224	188	91	48	107
Per cent composition								
Tolerant	33	47	62	100	78	96	94	100
Intermediate	0	19	12	0	0	2	2	0
Intolerant	67	34	26	0	22	2	4	0

[1] Three species that had fewer than five stems per acre in any plot are omitted.
[2] Trees have DBH over 2½ inches.
[3] Saplings have DBH 1½ to 2½ inches.

Maple, a number of trends are apparent. Height and density of the upper canopy increase while density of brush and ground cover decreases from Aspen to Maple (Table 1). Number of trees per acre and the proportion of trees made up by intolerant species decrease (Table 2). On the other hand, the proportion of trees belonging to tolerant species increases. A high proportion of saplings is tolerant in all plots.

These trends suggest that the plots represent an early stage (Aspen), two intermediate stages (Conifer–birch, Mixed), and a late stage (Maple) in forest development. However, they probably do not represent stages in a single succession. The Aspen and Conifer–birch Plots seem likely to become more coniferous. These stands may be regarded as local representatives of the boreal forest. The Mixed and Maple Plots will likely continue to support mixed or hardwood stands. This is not surprising since Algonquin Park lies in a transition zone between the boreal forest and the northern conifer–hard-

wood forest (as described by Brown and Curtis, 1952), and stands of both types are found on different sites within the area (Halliday, 1937).

Method Used to Study Territory

Territorial disputes between male Ovenbirds were observed from the time the birds arrived on the breeding grounds until after the young had left the nest. Most encounters consisted of chasing and vocalizing (call notes and songs) or only vocalizing, although physical contact was occasionally observed. Disputes were fewer, shorter, and less vigorous as the breeding season advanced. Not enough territorial disputes were observed to outline the area defended by any individual, i.e., to measure territory in the strict sense.

Instead, all locations where a male was observed were plotted and used to estimate the area utilized by that bird. Many of these locations were estimated when a bird was heard singing.

Occurrence of song distinguished males from females which are similar in plumage but do not sing. A few birds were marked with colored bands, but individual males were identified chiefly by differences in their songs. Tape recordings were useful for verifying identifications. Detailed analyses of songs will be published elsewhere.

Nine males were studied in 1955, and 13 in 1956. One observer watched a bird, taking care not to disturb it. When the bird was located, its position was marked on a map, and the height at which it was observed was recorded. Locations on the map were numbered consecutively. Each bird was studied one day a week, which amounted to eight or nine times during the breeding season in 1956. Fewer observation periods were completed in 1955. The observation period each day extended from 4:15 to 5:45 a.m. E.S.T. in 1955, and from 5:15 to 9:30 a.m. E.S.T. in 1956.

Total Territory Utilized During the Breeding Season

All locations where each male Ovenbird was observed from the arrival of its mate until its young left the nest were mapped as in Fig. 1. For each bird most of the points formed a compact group, but a few points (about five per cent) lay well outside this group. In order to determine the *total utilized territory*, the five per cent of points that were most isolated were rejected in all cases. Peripheral points of the remaining group were joined to form a polygon having no indentations (Fig. 1). Three of the birds (M 26, M 27, M 30) were not observed in certain open areas that lay within the polygons, and these areas were subtracted in finding the area of the total utilized territory. Areas were obtained from the maps using a compensating planimeter.

Points obtained during the premating period were excluded because there was sometimes a shift in the location of a territory when the female arrived. Points obtained after the young left the nest were excluded for two reasons. In the first place, the family group breaks up (Hann, 1937), and it is doubtful

whether most males still exhibit territorial behavior. Secondly, young birds were apparently not cognizant of the boundaries of the adult's territory and sometimes wandered beyond, in which case the male went beyond the boundary to feed them.

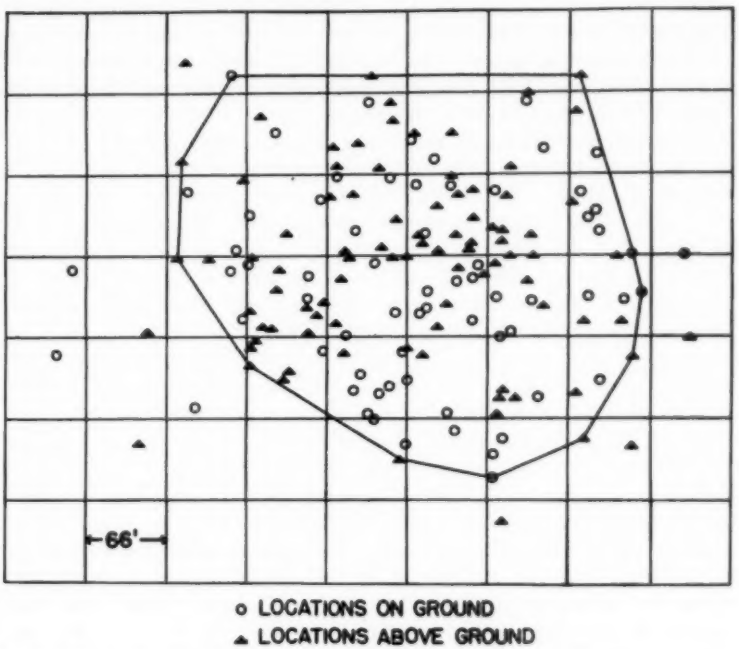

FIG. 1. Total utilized territory of M 20. Locations where the bird was observed are shown.

The *total utilized territory* as determined above is not necessarily identical with the area that a bird will defend if called upon to do so. However, it is an estimate of the area used during the breeding season by a male exhibiting territorial behavior. It is the segment of the environment in which most of the activities associated with the reproductive cycle are performed.

Distribution of activities.—Locations where male Ovenbirds were seen or heard did not appear to be concentrated anywhere but were scattered throughout the total utilized territory. Data for M 20 shown in Fig. 1 are typical in this regard. Most points represented locations where a bird sang in the trees but no particular song posts were used repeatedly. Prolonged vocalization occurred in any part of the territory where there were trees (usually deciduous)

of a suitable height (Fig. 1). The Ovenbird feeds almost entirely on the ground (Stenger, 1958), and nearly all observations of a bird on the ground represented feeding activity. When these observations are plotted separately (Fig. 1) they too are seen to be scattered throughout the territory.

Unforested areas that appeared to be similar to each other were used by some birds but not by others. Large open areas of bracken and grasses in the Aspen Plot were not used by M 26 and M 27, whereas M 23 and M 24 in the Conifer–birch Plot were observed to use similar areas. M 30 in the Maple Plot did not utilize an open wet area.

The total area utilized by a female was not determined. However, a female was sometimes observed in company with a male or was flushed from its nest and could then be followed. Females were not observed beyond the boundaries of their mates' territories. However, they did not appear to take an active part in defense of the territory. The nest was located within the total utilized territory although often near the edge.

Buffer zone.—When total utilized territories of neighboring birds are drawn on a map there is usually a *buffer zone* (Williamson, 1956) between them. An example is shown in Fig. 2 where all the territories except those of M 4 and M 5 were separated by approximately 60 feet. In the Maple Plot, where territories were largest, the buffer zone was about 100 feet wide.

Sometimes there appears to be considerable overlap between adjacent territories as illustrated in the Mixed Plot in 1956 (Fig. 3). This results from shifting of territories during the breeding season; territories utilized by adjacent birds on any one day were always well separated.

Most of the points rejected in the estimation of total utilized territory occurred in the buffer zone. When a bird was observed in the buffer zone it either did not sing at all or gave one or two weak songs. These observations suggest that Ovenbirds recognize the boundaries of their territories since they behave differently in the buffer zone than inside the total utilized territory.

Extent of the total utilized territory.—All the birds that were studied occupied fairly compact territories approximately circular or oval in shape (Figs. 1–3). The size of these areas varied considerably as shown in Table 3. The total utilized territories of M 5 and M 7 were smaller when they were unmated than when they were mated. When birds renested (this occurs only when the first attempt at nesting fails) they occupied larger territories in two cases (M 5, M 32) and a smaller territory in one case (M 28) than during the first attempt at nesting. They did not change location, however (Fig. 3).

The greatest differences in size of territory occurred among different forest types. Considering first nesting attempts in 1956, for the 11 birds for which comparable data are available (omitting M 7 and M 32), the average sizes of territories in the different plots are: Aspen 1.8 acres; Conifer–birch 2.2 acres; Mixed 2.4 acres; and Maple 3.3 acres. The same trend is shown in 1955

for the Aspen, Mixed, and Maple plots. It was pointed out in the section dealing with study areas that when the plots are placed in this order they show a number of trends in the structure and composition of the forest. Thus, territory size increases as canopy height and density increase, as brush and ground vegetation decrease, and as the forest changes from an early seral stage with many intolerant trees, to a late stage in development characterized by fewer but more tolerant trees. These trends are quite marked when the territories in different plots are compared, but do not hold in every case within plots. These features of the habitat may affect the behavior of the birds, or may determine differences in the supply of food available to Ovenbirds, or both. The relationship between available food and size of territory is considered in a separate paper (Stenger, 1958).

Height of the territory.—The space occupied by a bird is a volume rather than an area and has a measurable height. It can be argued that a more accurate account of territory might be attained by comparing volumes. This

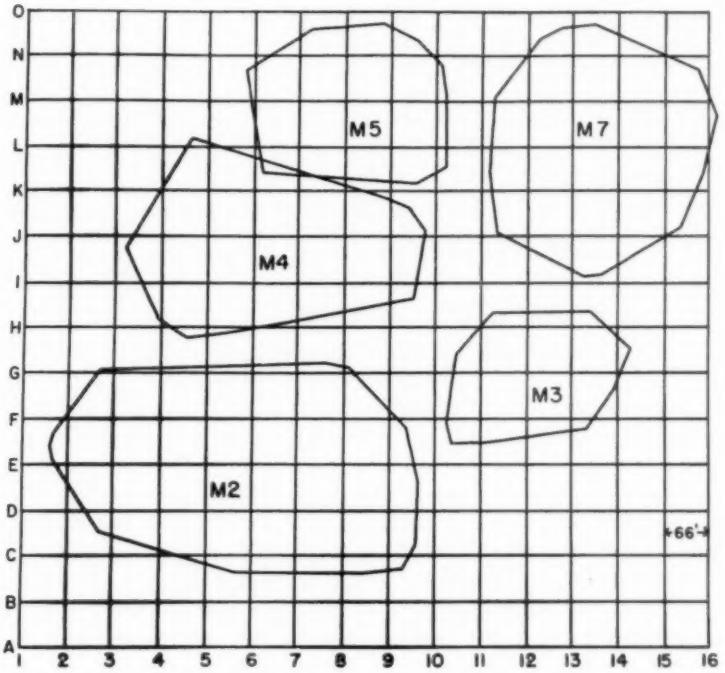

FIG. 2. Total utilized territories in Mixed Plot in 1955.

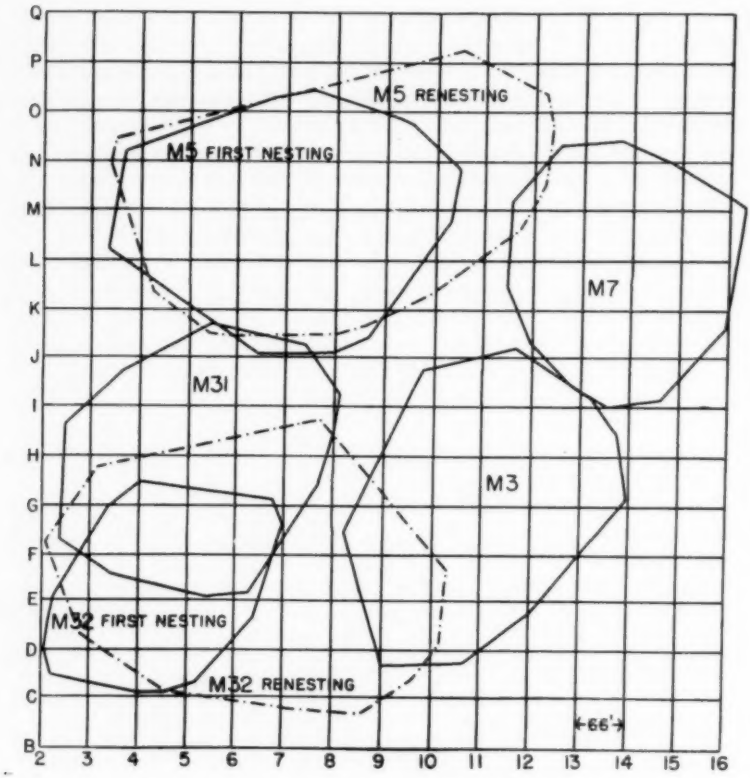

FIG. 3. Total utilized territories in Mixed Plot in 1956.

would necessitate measuring the height of each territory. Greater height might compensate for smaller area or height might be related to area in some other way.

The height of the space occupied by a male Ovenbird was estimated by finding the average height of the highest 25 per cent of points where the bird was observed. Analysis of data from territories of nine Ovenbirds showed that the vertical extent of activity was a little less than the height of the densest layer of the forest canopy. This resulted from the fact that Ovenbirds usually sang from the lower branches of the canopy. The vertical extent of activity was not clearly related to the area of the territory. Height values were less variable than areas of territories and did not compensate for them. Thus, if

volumes were calculated from these dimensions, they would be more variable than the corresponding areas.

These results, together with the fact that this species feeds and nests on the ground, indicate that, for the Ovenbird, the area of the total utilized territory is more meaningful than the volume of space occupied.

TABLE 3

VARIATION IN SIZE OF TOTAL UTILIZED TERRITORY AMONG FOREST TYPES

Forest type	1955		1956		
	Bird	Territory (acres)	Bird	Territory (acres)	
				First nest	Renest
Aspen	M 15	1.0	M 28	1.5	1.1
			M 26	1.9	
			M 27	2.1	
Conifer-birch			M 24	2.1	
			M 20	2.2	
			M 23	2.2	
Mixed	M 5[1]	0.8	M 5	2.7	3.6
	M 9	1.6	M 31	2.2	
	M 4	1.7	M 3	2.4	
	M 7	2.0	M 7[1]	1.8	
	M 10	2.1	M 32	1.5[2]	3.4
	M 2	2.8			
Maple	M 12	3.9	M 30	2.5	
	M 13	4.3	M 29	4.0	

[1] Unmated.
[2] Based on observations on only two days.

CHANGES IN UTILIZED TERRITORY AS THE BREEDING SEASON ADVANCES

A distinction can be made between the total utilized territory for the breeding season and the area utilized on one day. Changes in the area utilized daily may be observed as the breeding season advances.

The observation-area curve as a means of estimating utilized area.—Odum and Kuenzler (1955) used the observation-area curve as a standard method of measuring size of territory for comparative purposes. After each 10 consecutive observations were mapped, they plotted the area outlined by all the observation points against the total number of observations. At first, the area increased as more observations were included, but later the curve leveled off. Odum and Kuenzler selected as a standard, for comparison of different territories, the area obtained when there was less than one per cent increase in area for each additional observation.

This method has been modified and extended for the treatment of Ovenbird

data. Instead of mapping the location of a bird every five minutes, as Odum and Kuenzler did, all different locations where a bird was observed were recorded. This resulted in approximately 12 to 15 locations per hour. Points were plotted on the observation-area curve after each five consecutive observations.

In the present study there were a number of days when the birds were inactive. On such days, the number of locations visited by a bird were too few to reach the level portion (or the level of one per cent change) of the observation-area curve. Since the area utilized can change substantially from one day to the next in the case of the Ovenbird, there seemed to be no justification for combining observations made on different days and in different weeks. In order to reach the one per cent level on the observation-area curve, 60 or more locations were usually required and this number was obtained only two or three times for each bird during the breeding season. It was relatively easy, however, to obtain 30 to 40 locations on any one day. As few as 20 locations were sufficient to estimate the slope of the initial portion of the observation-area curve. This slope was estimated by calculating a line of best fit to the points on the initial portion of the curve.

The slope of the initial part of the observation-area curve is proportional to the area reached at the level portion of the curve. This is shown in Fig. 4, in which slopes of the initial portions of the curves are plotted against the final areas for all those occasions when the level portion of the curve was attained (at least the last three points at the same level). Points on the level portion of a curve were excluded in calculating the slope.

The relationship shown in Fig. 4 means that the rate of increase in area per observation is greater when the area is larger, and suggests that successive locations at which an Ovenbird is observed may be farther apart when the bird visits a larger area. This was tested by measuring the distances between consecutive observation points and comparing the mean distance obtained with the area reached at the level portion of the observation-area curve. Fig. 5 shows that distances between points were greater when the area utilized was larger.

Thus, there is a reasonable basis for relating the slope of the initial portion of the observation-area curve to the final area reached by the curve. This relationship was used to estimate the areas utilized by Ovenbirds on days when only enough data were obtained to calculate the slope of the initial portion of the curve. A line of best fit was calculated for the data in Fig. 4. Given a slope value, a corresponding area can be read from this graph or calculated from the equation of the line, $Y = .005 + .0199X$.

Estimates of utilized area obtained in this way should not be regarded as very accurate in view of the rather wide scatter in Fig. 4. Since the error is likely to be greater if the area is large, no definite values were assigned to

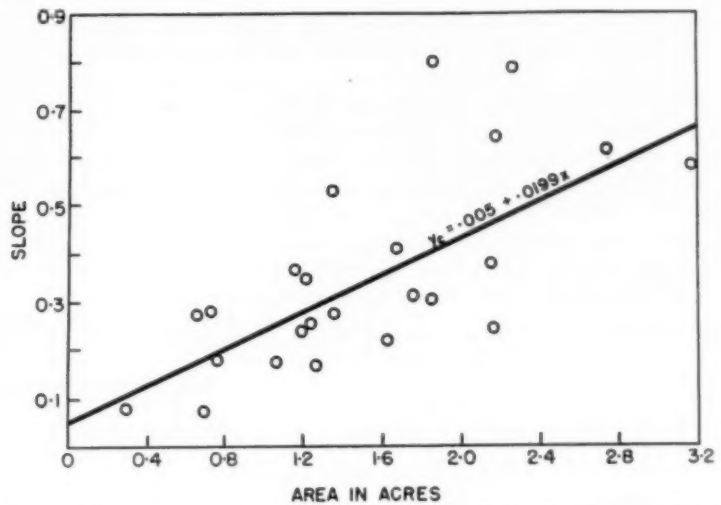

FIG. 4. Relation between slope of the initial portion of the observation-area curve and the final area reached by the curve. The line of best fit to these data is shown.

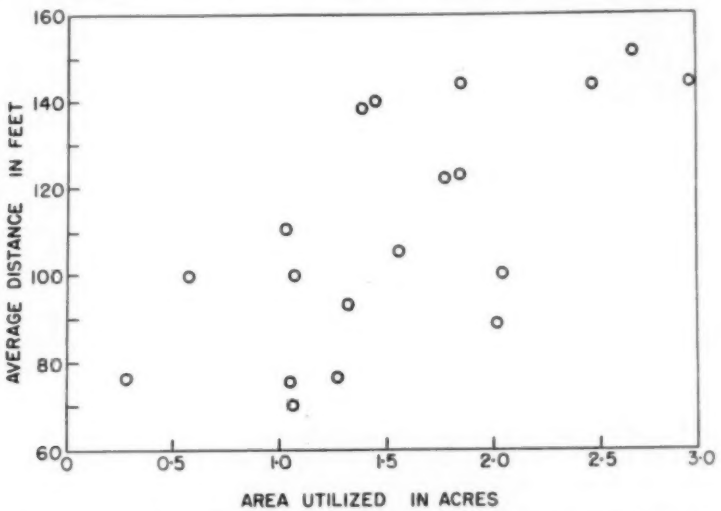

FIG. 5. Average distance between successive locations at which a bird was observed in relation to area utilized. Area utilized is taken to be the area reached at the level portion of the observation-area curve.

estimated areas in excess of four acres. This method made it possible to use data which would otherwise have been rejected as incomplete.

Changes in the area utilized by the male during the reproductive cycle.—The duration of the different stages of the breeding cycle were determined for a few Ovenbirds whose nests were found. Where nests were not found young birds were easily discovered after they had left the nest and could be aged approximately. Data on the breeding cycle obtained in this way agreed with the more extensive information given by Hann (1937); therefore his time intervals were used to fix approximate dates of the different stages of the breeding cycle for birds where only the young were found.

The following is a brief summary of the Ovenbird's breeding cycle:

Premating	—period from arrival of male to arrival of female; about 13 days in 1955, and about 18 days in 1956.
Mating	—a period of variable length from arrival of female until nest-building begins.
Nest-building	—5 days for first nest, 4 days for renesting.
Egg-laying	—3 to 5 days, depending on number laid.
Incubation	—12 days, beginning with second-last egg.
Nestling	—7 to 9 days.
Young leave nest	—young leave nest in about 9 days, fly in about 11 days, and are independent about 30 days after hatching.

Using the method outlined in the previous section, the area utilized by each bird in each observation period was estimated and the values obtained were assigned to the appropriate stages of the breeding cycle. These values, expressed as fractions of the total utilized territory, are shown in Fig. 6 for the 11 birds for which the necessary data were available. Since no one bird was studied during every stage of the breeding cycle, all the values obtained in each period were averaged and are shown in the final histogram. In interpreting these histograms, it must be borne in mind that measurements were not made at precisely the same stages for all the birds, even within the main periods of the breeding cycle.

Two major peaks in the size of the area utilized occurred during the breeding cycle (Fig. 6), one during the premating and mating periods, and the other during the incubation and nestling periods. During these two peak periods the average area utilized by the male in one day was almost as large as the total utilized territory. During the period between these peaks (nest-building and egg-laying) the average area was about half the size of the total utilized territory. These marked variations in area utilized can be explained in terms of the male's activities.

In the premating period, when the area utilized is large, the male establishes his territory. He sings often and encounters with other males are frequent. Six of eight males for which data are available showed an increase in area

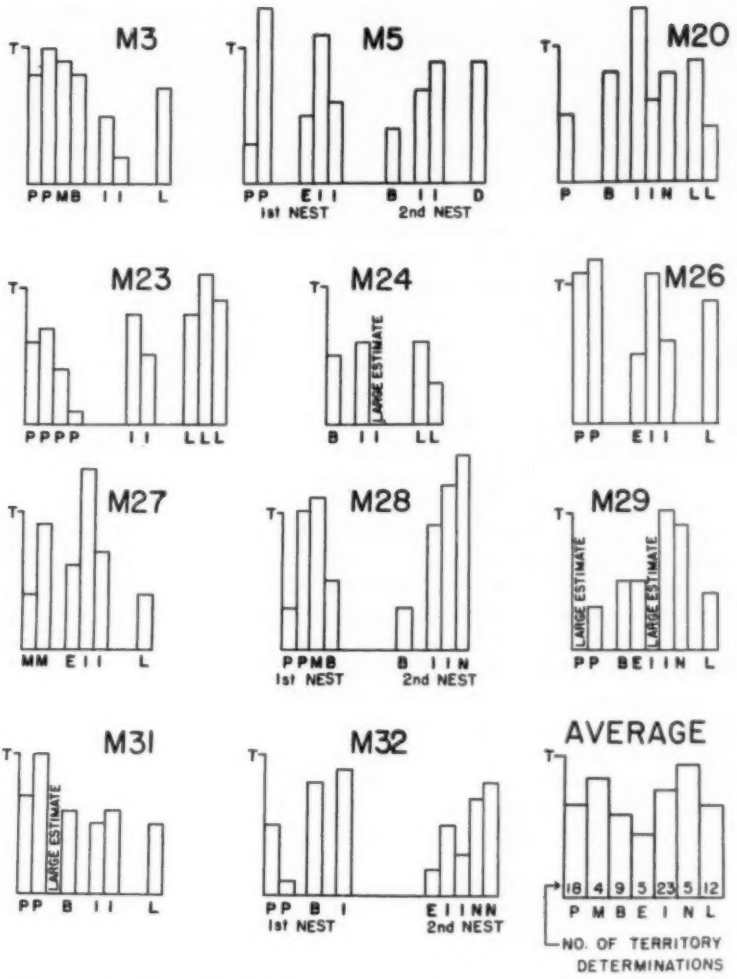

FIG. 6. Area utilized in different periods of the reproductive cycle expressed as a fraction of the total utilized territory (T) for each bird. Average values for all birds for each period of the reproductive cycle are given in the final histogram. Periods of reproductive cycle: premating (P), mating (M), nest-building (B), egg-laying (E), incubation (I), nestling (N), and after young have left nest (L).

utilized during this period. One bird (M 23) that had an extended premating period showed a decrease in the area utilized following the initial increase.

Three males were studied in the period between the arrival of the females and the beginning of nest-building. In this mating period the area utilized by the male was large.

From the time the female began building the nest until she started to incubate, the area utilized by the male was small (less than in earlier periods in 6 out of 8 cases). In this period the male sings infrequently and is often seen with the female although he does not help build the nest. Copulation takes place mainly in this period (Hann, 1937).

During the incubation period, the area utilized once again increased in 10 out of 12 cases. The male does not take part in incubation and is seldom seen with the female at this time. He sings about as often as during the premating period. Most males (8 out of 12) showed a small decrease in area utilized toward the end of this period.

During the nestling period the male helps feed the young. He sings infrequently and is secretive, and is therefore difficult to observe. Adequate data were obtained for only four birds, all of which utilized areas about as large as, or larger than during the incubation period.

When the young leave the nest the brood is divided between male and female. In this period some males (5 out of 10) utilized larger areas than previously, whereas others used smaller areas. If there are several young they tend to disperse rather than to stay together. It may be that males tending more than one young utilized a larger area during this period than those tending a single young bird.

Thus, the size of the area a male Ovenbird utilizes varies during the breeding season. It is large when he is occupied with territorial defense, advertising song, and food gathering for the young, and small when he spends his time with the female and copulation is frequent. While the areas utilized by males change markedly, no conclusions concerning the area utilized by females, or changes in size of defended territories can be drawn from the data presented in this paper.

Apparently the Ovenbird is somewhat different from certain other species in regard to changes in size of the territory occupied as the breeding season progresses. Young (1951) thought that territories of the Robin (*Turdus migratorius*) shrank progressively as the breeding season advanced, while Odum and Kuenzler (1955) found that for a number of species territories were smaller during the nestling stage than during nest-building and incubation.

Acknowledgments

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Summary

Territories of Ovenbirds were studied in four forest types in Algonquin Park, Ontario. Locations where a male was observed were used to estimate its *total utilized territory* for the breeding season. Birds were observed singing or feeding in all parts of their territories, although some birds did not utilize open areas. Total utilized territories of adjacent males were usually separated by a buffer zone but occasionally overlapped. However, areas used by adjacent males on any one day were always separated.

Total utilized territories varied from 0.8 to 4.3 acres, being small in an aspen stand, intermediate in size in conifer–birch and mixed stands, and large in a maple stand. Thus, the size of the territory increased with increasing height and density of forest canopy, and with decreasing vegetation near the ground. Unmated birds had small territories.

The vertical extent of each bird's activity was related to the height of the forest canopy where the bird sang, but not in any regular way to the area of its territory.

A method was developed to compare the areas utilized by male Ovenbirds on different days during the breeding season. The area utilized was large during the premating and mating periods, smaller during nest-building and egg-laying, and large again during the incubation and nestling periods. Thus, the area utilized by a male Ovenbird is large when he is occupied with territorial defense, song, and feeding the young, and small when he is often with the female and copulation is frequent.

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THE SONGS OF THE GRASSHOPPER SPARROW

BY ROBERT LEO SMITH

In the spring of 1944 I began a four-year, life-history study of the Grasshopper Sparrow (*Ammodramus savannarum*) near Reynoldsville, Jefferson County, Pennsylvania. This paper deals with the songs; a second paper will cover the ecology and life history of the species.

The male Grasshopper Sparrow possesses three primary forms of vocalizations that I have designated the Grasshopper Song, the Sustained Song, and the Trill; and the female one, the Trill. Others (Eaton, 1914:292; Saunders, 1951: 254; Todd, 1940:630; Walkinshaw, 1940:56) have observed that the male sang at least two different songs, but apparently they attached little significance to this. After one summer of observations I was aware that each song more or less served a definite purpose and was characteristic of a particular period in the breeding cycle. Attention was given to this problem during the following seasons with emphasis on (1) the relationship of the songs to territorial establishment, mating and nesting; (2) the behavior of the birds while singing; and (3) the responses elicited in rival males and females.

During 1946 and 1947 a daily account was kept of the singing of 12 different males for a total of 14 individual records. Weather conditions, the different songs given during the day by each male, and song in relation to the time of day were recorded. In late summer when song diminished, observations began before dawn and concluded at dark in order to include any occurrence of song during this period.

Description of the Songs

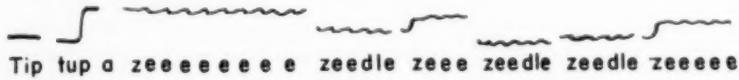
Grasshopper Song.—The most familiar of all the songs of the Grasshopper Sparrow is the one from which the bird derives its name, the Grasshopper Song. It is one to three seconds in duration and possesses an insect-like quality which has been likened to the stridulations of the long-horned grasshopper (*Conocephalus*). The song has two variations, common to all individuals, and are represented as follows:

To the ear the Grasshopper Song is remarkably consistent. There does not appear to be the wide individual variations in song found in many fringillids. Extensive spectrographic studies probably would prove otherwise. I have met, however, with two outstanding exceptions. In the first instance the individual consistently sang a song that was remarkably similar to that of a cicada (*Tibicen* sp.). In the second instance the bird gave a weak, husky trill with great effort.

I have been able to detect a reedy quality in the songs of other individuals, but this never proved to be a reliable means of distinguishing the individual from neighboring Grasshopper Sparrows.

The males sing the Grasshopper Song from a grass stalk, low bush, fence post, 10 to 30 feet up in a tree, or from electric power lines. During the height of territorial establishment this song may be sung up to 220 times an hour.

The Sustained Song.—The second vocalization of the Grasshopper Sparrow is more elaborate and more musical than the Grasshopper Song and is subject to more individual variation. The Sustained Song, which may vary from five to 15 seconds in length may be represented as follows:



At times the "grasshopper" introduction is omitted and the song then consists of the last phrase only.

The Sustained Song is not confined to perch singing alone. The male often sings it in flight, either alone or while pursuing the female. The male rises out of the grass on quivering wings, delivers this song in a low, fluttering flight and then drops down into the grass again.

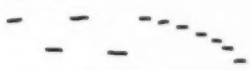
Even though this song can be heard frequently during the mating and nesting season and during summer evenings, it is surprising how much confusion has developed regarding it. Saunders (1951:254) considered what obviously is the Sustained Song as a post-season elaboration of the typical Grasshopper Song. Todd (1940:630) stated that it probably was a mating song. Eaton (1914:292) stated that Gerald Thayer considered this the true song of the species. Jouy (1881:58), apparently on mistaken identification, attributed this song to Henslow's Sparrow (*Passerherbulus henslowii*). He wrote:

"Besides their characteristic note of *te-wick*, they have quite a song which may be fairly represented by the syllables *sis-r-r-rit-srit-srit*, with the accent on the first and last parts. This song is often uttered while the bird takes a short flight upward; it then drops down again in the tangled weeds and grasses where it is almost impossible to follow it."

This is an adequate description of the Sustained Song of the Grasshopper Sparrow which is often given in flight. Fortunately both the Grasshopper and Henslow's sparrows nested in the study area. Not once in five years of observations of both species have I heard a Henslow's Sparrow sing a song that even remotely resembled the Sustained Song of the Grasshopper Sparrow. A similar view was given by Sutton (1928:179–182).

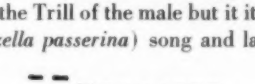
The Trill.—The male possesses still another vocal performance, the Trill, which seems to be confined to mated birds. It is the least common of the vocalizations and, unless one is frequently afield, it is apt to be missed entirely.

Saunders (1951:254) gives a graphic description of the Trill, although he does not seem to recognize it as a distinct type of vocalization. Walkinshaw (1940: 59) described it as a nesting song. It consists of a series of moderately loud notes on two tones, rapidly given:



It may be delivered either from a perch or in the grass.

The Trill of the Female.—The female Grasshopper Sparrow possesses a vocalization quite similar to the Trill of the male but it it weaker, suggestive of the Chipping Sparrow's (*Spizella passerina*) song and lacks the downward trill:



It is difficult to observe the female singing because, except in courtship flights, she delivers this song while concealed in the grass. On May 21, 1945, I had an excellent opportunity to observe the female uttering the Trill. She appeared in a small bare area in some rather sparse grass near the boundary of a hay and wheat field. Flirting her tail and hopping slowly about in a circle she delivered the Trill. Then she flew into the wheat where she sang it again.

The female may sing this trill in answer to the Sustained Song or the Trill of the male, or she may give it without the stimulus of the song of the male.

Periods of Song

Singing falls into seasonal and daily patterns (Fig. 1). The seasonal distribution of song is influenced by the reproductive cycle of the bird; the daily pattern is influenced by the seasonal pattern and by daily weather conditions.

Grasshopper Sparrows are in song when they return to their breeding areas in mid-April. The average date over a 5-year period for their arrival on the study area was April 16. The earliest arrival was March 31, 1945, the earliest ever recorded for western Pennsylvania, and the latest arrival was April 21, 1946. The entire population on the study area did not arrive at once, but built up over a period of a week. During the first days following their arrival the males sang only the Grasshopper Song and confined their singing to the morning hours. As the population increased during the succeeding days, the males sang the Grasshopper Song more and more frequently, until they were heard throughout the day.

Within 10 to 14 days after their arrival, the males introduced the Sustained Song. At first each male may sing this song no more than two or three times a day, but within a week he almost replaces the Grasshopper with the Sustained Song for a few days. In general, however, it is given interchangeably with the

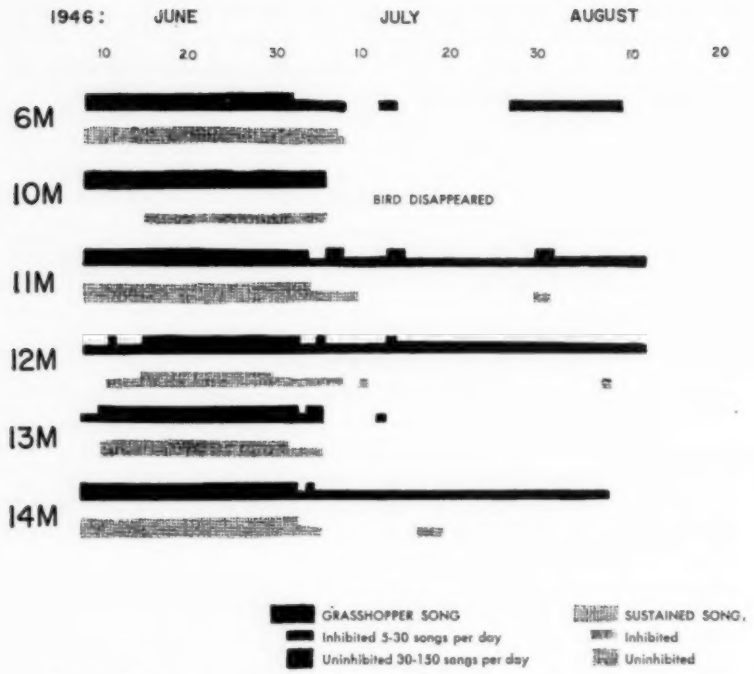


FIG. 1. Frequency of song among Grasshopper Sparrows during summer, 1946.

Grasshopper Song and is rarely sung for any length of time without interruption by the Grasshopper Song.

After pairing all song appears to be inhibited for a few days, but the birds I observed never ceased singing entirely. During the period of egg-laying and incubation, the male sings both songs frequently, especially in the early morning and evening, continuing until darkness. Occasionally a bird may sing sporadically throughout moonlight nights.

During June, when most Grasshopper Sparrows are feeding young, song wanes. The Sustained Song is heard less frequently during the day and more or less assumes the status of a twilight song. The Grasshopper Song is again the common daytime song; but prior to renesting the Sustained Song becomes conspicuous for several days, then wanes again. By mid-July the Sustained Song has all but disappeared and is sung only occasionally from then until the cessation of song in mid-August. The Grasshopper Song, however, is retained

and is sung with diminished vigor and frequency as the summer wears on (Fig. 1).

After pair formation in late April the male introduces the Trill. He gives this infrequently and only on specific occasions. After nesting is completed and the young are on the wing, the male drops the song.

The Trill of the female is heard from the time of pair formation to the cessation of nesting.

The Grasshopper Sparrow does not have an extended morning awakening song. Upon awakening the bird may remain silent and start to feed, it may utter the *chi-ip* call note or it may sing the Sustained or Grasshopper Songs. Once the bird commences singing, it interrupts the song sequence frequently with feeding.

By mid-July the daily pattern gradually assumes a different character. The Sustained Song is dropped except for a few occasional days when it may be given several times in the very early morning or at evening twilight. Morning song has nearly ceased and daytime song is rarely heard. The cooler temperatures of evening and the suspension of feeding activity bring in the twilight song which lasts until darkness comes. At this period the Sustained Song, with its greater carrying power, seems to be the most conspicuous and for this reason has been erroneously described as a post-season elaboration of the regular song of the species.

Song may be inhibited by adverse weather conditions. For example, in 1945 spring came exceptionally early. In late March temperatures were in the high 70's and low 80's, leaves were opening and the grass was three inches high. As might be expected, the Grasshopper Sparrows returned very early, on March 31. Song increased in volume up to May 1, when cold, wet weather set in. Song nearly ceased. On May 9 the weather cleared, and although the temperature was 30°F., all Grasshopper Sparrows broke into song. Hot, humid weather also has an inhibiting effect on song, but not to the extent of cold, wet weather.

Functions of Song

The objective study of the function of bird song has suffered from the lack of a suitable definition of bird song. Howard (1920) in his pioneer work on territorialism in birds emphasized the advertising function of song. Tinbergen (1939:73) regarded bird song as an utterance "that serves to attract a sex partner, to warn off a bird of the same sex or both." Nice (1943:144–149) and Lack (1943:28–33) also considered song from this viewpoint. More recently, Moynihan and Hall (1954:50) suggested that the term "song" be confined to those vocalizations with the dual functions of warning rivals and attracting mates. On the other hand, Armstrong (1947:294) stated that from a functional point of view no distinction can be drawn between songs and calls.

For the purposes of this paper, and of attempting more clearly to distinguish song from other vocalizations of a bird, song is regarded as a vocal utterance, long or short, simple or complex and species specific, which is given by either sex or both and which functions primarily to repel rivals of the same species, to attract a mate, or both.

This definition is exclusive to the point that it eliminates any vocalizations, however complex, which do not serve primarily to attract or repel. At the same time it does not assume that song is exclusively the function of the male. It thus includes the rarer instances of song in female birds. The words "functions primarily" do not eliminate the post or pre-breeding season songs of many birds. Other musical utterances not serving to attract or repel should be considered sub-songs and all other vocalizations as calls.

The Grasshopper Song.—Its peak occurrence early in the season and its consistent appearance in daytime and evening singing up to the complete cessation of song suggest that the Grasshopper Song is territorial in function.

The behavior of the bird itself, however, is even stronger evidence that the song is hostile. During territorial establishment the male alternates song with display. In a crouched position with his head lowered between his shoulders (Fig. 2, A), the male raises and flutters one or both wings (Fig. 2, B). The primaries and secondaries are not extended, but the wing is fluttered quickly above the back at the humerus. Then, after hearing the song of his neighbor, the bird stands erect and sings back (Fig. 2, C). The song completed, the male again assumes the crouched position and flutters his wings. The sequence is as follows: (1) The male stands erect and sings the Grasshopper Song. (2) Song completed, he assumes the crouched position. (3) He flutters one wing or both simultaneously. (4) He hears rival's song, and rises to a singing position. (5) He sings Grasshopper Song.

The wing-fluttering of the Grasshopper Sparrow is never accompanied by a song or a call, but is confined to that interval between songs, and is conspicuous only during the period of territorial establishment.

It seems unusual that this behavior has not been reported by other writers. The only comment on wing-fluttering by the Grasshopper Sparrow that I have found was made by William Brewster (1874) in his unpublished Nantucket journal for July 3, 1874: ". . . I have a new one, namely that the bird frequently quivers its wings like a Bluebird."

Wing-fluttering is closely associated with territorial establishment. Some manner of wing-fluttering occurs in the mating and territorial behavior of a number of passerine species, for example, the Snow Bunting, *Plectrophenax nivalis* (Tinbergen, 1939:17); the Song Sparrow, *Melospiza melodia* (Nice, 1943:154); the House Wren, *Troglodytes aedon* (Kendeigh, 1941:21); the European Wren, *Troglodytes troglodytes* (Armstrong, 1954:47, 114–117); the European Goldfinch, *Carduelis carduelis* (Hinde, 1955:720); the Canary,

Serinus sp. (Hinde, 1955:713–715); and the Greenfinch, *Chloris chloris* (Hinde, 1955:719). The stimuli for these displays differ from those of the Grasshopper Sparrow. One male has actually invaded or is threatening to invade the territory of another; the birds see one another; or often they are face to face. The Grasshopper Sparrows in most instances do not see one another. The males may be hidden from one another by the vegetation or the topography of the field. They do not erect the body feathers. The attitude, however, of the male between songs, the crouched posture with the bill pointed forward, the fluttering of the wings, the apparent readiness of the bird to move forward to meet a threat, all strongly indicate that this is a hostile display. During the period of territorial establishment the song of a rival is a sufficient stimulus to release this display. The bird senses the presence of a rival by the sound of his song and manifests this by a hostile display, as if the rival were nearby in the grass. Marler (1956:497) has observed a similar reaction in the Chaffinch (*Fringilla coelebs*). The song of the Chaffinch played through a loud speaker induced fierce aggressive display in males.

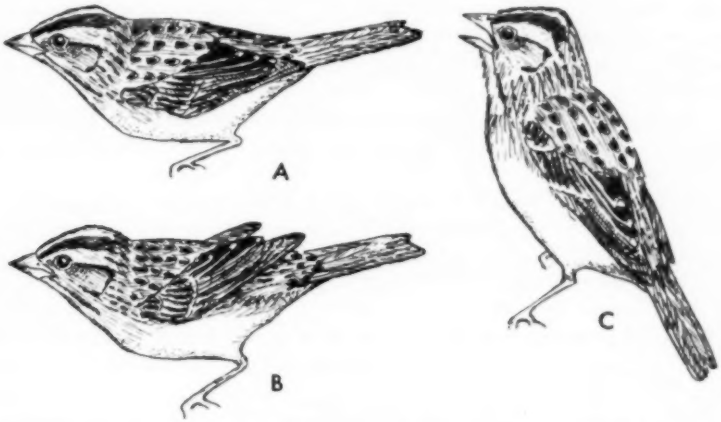


FIG. 2. Attitudes of male during the Grasshopper Song sequence. (A) crouched position. (B) Wing-fluttering. (C) Delivering song.

Unfortunately I have never observed among Grasshopper Sparrows a territorial dispute that elicited a high intensity intimidation display. If any occurred it happened out of sight in the grass. The only physical encounters I have observed during hundreds of hours spent with the species were those after a bird saw another invade its aerial territory. In each instance the bird chased the intruder, then retired to a singing perch, fluttered his wings and sang the

Grasshopper Song. I have witnessed a number of aerial clashes at disputed territorial boundaries. In fact, this mode of defense could be the most important, because the deep grass would generally conceal territorial infringement on the ground. Perhaps the Grasshopper Sparrow recognizes the limits of its territory only from a grasstop point of view.

The Grasshopper Song, then, serves primarily as an advertising or territorial song. The distribution and occurrence of this song during the season, its timing, and the response it elicits from neighboring males emphasizes this function. It is the first song given by the male in the spring and is delivered from the highest perch in the territory. It is sung when one male is chasing another from his territory, and is delivered by both when the two retire to their singing posts.

At times the Grasshopper Sparrow will deliver the Grasshopper Song while protesting other animal or human intrusion. On occasions male Grasshopper Sparrows protested my presence in their territories. As soon as I left they would return to their singing perches and deliver the Grasshopper Song.

The Sustained Song.—The Sustained Song attracts a mate. Its occurrence in the seasonal song cycle, its loudness, and the response it elicits from the female indicate this function. Upon hearing the Sustained Song, the female will answer the male with a Trill (Fig. 3). In turn, the male will respond to the female's vocalization by answering her with the Sustained Song again, or by flying to her.

The function of the Sustained Song cannot be limited to attracting a mate. If that were its sole purpose it should cease upon the arrival of a female, as in the case of the Snow Bunting (Tinbergen, 1939:77). The song, however, is delivered through the periods of nesting and caring for the young. Furthermore, it is given with increased frequency just prior to the second nesting. Apparently this song is quite important in maintaining the pair bond throughout the season.

The complete Sustained Song with the "grasshopper" introduction is hostile to other males. The first phrase of the song is identical to the Grasshopper Song. This is necessary in the early period of courtship because the territories have been newly settled by the males and the warning function still is of prime importance. The second phrase of the song, however, serves to attract and hold a mate. Later in the season, when territories are well established and the warning is not so imperative, the majority of Sustained Songs lack the "grasshopper" introduction. When one male hears another singing the Sustained Song, he responds not with the Sustained Song but with the Grasshopper Song. Then both birds launch into a song duel of Grasshopper Songs.

The Trill.—The Trill generally is not given by the male until the pair is formed and even then it is usually uttered only in the vicinity of the nest, and only from a perch or in the grass. It may follow one of the other two songs or it may be given alone, often in answer to the female (Fig. 3). It is also given by the male when he is in close proximity to the nest.

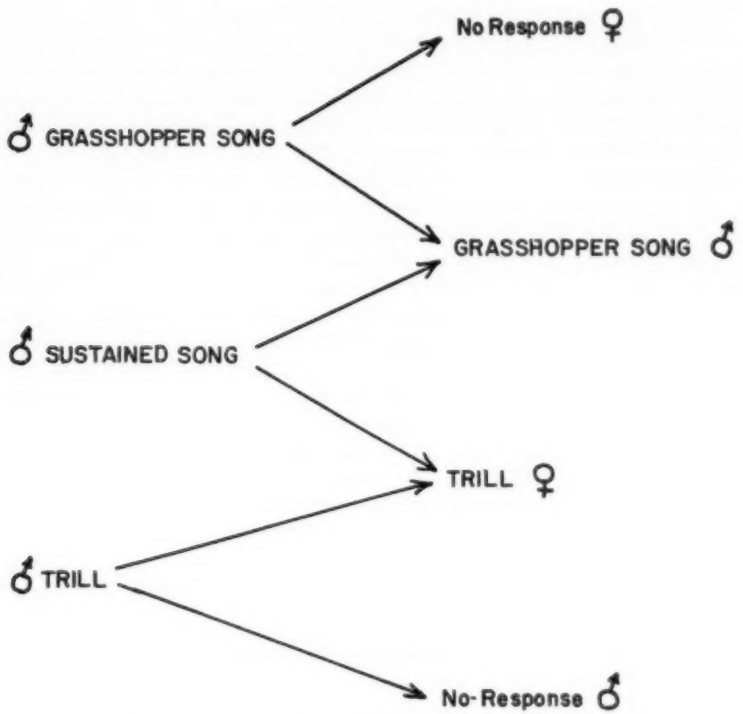


FIG. 3. Responses of male and female Grasshopper Sparrows to the several songs.

The Trill apparently serves as a bond to hold the pair together, and as a signal to both the female and the young that the male is approaching the nest. The fact that the Trill usually is given only by the mated male seems further to support this function. Only once did I hear the Trill given by an unmated male, several of which I have followed through a season.

The Trill of the Female.—The Trill is a distinctive vocalization of the female which may or may not be given under the stimulus of the song of the male. The fact that the female Grasshopper Sparrow vocalizes should not be regarded as unusual, but the problem is whether or not this vocalization can be regarded as true song.

The manner and circumstances under which the Trill of the female is sung, and its function, indicate that it can be. Just as the male Grasshopper Sparrow can detect the presence of a rival in his territory by the rival's song, so can he

detect the presence of a female by some distinctive signal. Herein lies the significance and the biological importance of the female's song. When the male sings the Sustained Song, he proclaims his availability to a female. A female bird present on his territory answers with a vocal performance which is loud, species specific, and which advertises her presence to the male. In fact she sings this Trill independent of any song from the male. Hearing the female, the male flies to her.

The importance of the female's song as an attracting mechanism is apparent. The male does not have to see by chance a strange bird in his territory and then challenge it to determine its sex. Because of the nature of the habitat this might be difficult and time consuming. Instead, the song of the female assures that the male will be led to a potential mate, that this potential mate is of the male's own species and that the male will have the opportunity to find a mate at the proper time in the breeding cycle.

The female also gives the Trill when she is approaching, or is in the vicinity of the nest.

The primary function of the Trill of the female Grasshopper Sparrow is to declare her presence to the male, to announce her location, to maintain the pair bond, and to signal both the male and the young that she is approaching the nest.

Acknowledgments

For comments and suggestions I am indebted to Merrill Wood, Charles G. Sibley, Ralph Palmer and the late Josselyn van Tyne. I wish to thank the librarians at the Museum of Comparative Zoology, Harvard University, for their assistance in securing all the notes on the Grasshopper Sparrow from the unpublished journals of William Brewster, and for permitting me to examine them.

Summary

The male Grasshopper Sparrow possesses three primary forms of vocalizations, the Grasshopper and Sustained Songs and the Trill, and the female Grasshopper Sparrow one, the Trill.

The male sings the Grasshopper Song from mid-April to mid-August. The Sustained Song is introduced approximately at the time the females arrive. It is sung with diminished vigor until mid-July and only sporadically from then on until the cessation of song in mid-August. The Trill is given from the period of pair formation to the completion of nesting, as is the Trill of the female.

Early in the season song is heard throughout the day. After mating, song is inhibited but does not cease entirely. During the periods of nest-building, incubation and care of the young, song is confined primarily to morning and late evening. Song is inhibited by adverse weather.

The Grasshopper Song is the familiar song of the species. It is used primarily to proclaim and defend territory. During the period of territorial establishment the male assumes a crouched, bill-forward position and flutters his

wing or wings between songs. This is regarded as a hostile display released by the song of the rival.

The Sustained Song in its entirety consists of a "grasshopper" introduction and a sustained series of melodious notes. After the territories are well established, the "grasshopper" introduction is usually dropped. The primary function of the Sustained Song is to attract a mate, but the "grasshopper" introduction is hostile in character. A secondary function of the song is to maintain the pair bond.

The Trill serves to maintain the pair bond and to signal the mate and the young of the male's approach to the nest. It apparently is given only by mated males.

The Trill of the female advertises the presence of a potential mate in the male's territory and identifies her species and sex. The Trill also serves to maintain the pair bond and to signal the male and the young that she is approaching the nest.

The male Grasshopper Sparrow responds to the Grasshopper and Sustained Songs with a Grasshopper Song, to the female's Trill with a Sustained Song or a Trill. There is no response by the male to the Trill of another male. The female responds to the Sustained Song and the Trill of the male with her Trill, but shows no apparent response to the Grasshopper Song.

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DIVISION OF FORESTRY, WEST VIRGINIA UNIVERSITY, MORGANTOWN, WEST VIRGINIA, MARCH 21, 1958

FOOT-STIRRING FEEDING BEHAVIOR IN HERONS

BY ANDREW J. MEYERRIECKS

A PECULIAR type of feeding behavior, described by various authors as "stirring," "scraping," "raking," and so on, has been recorded for several species of herons and other birds (see, for example, Rand, 1956). Briefly, the feeding heron extends one leg and vibrates or quivers it, especially the foot, then stabs at any prey that darts from the disturbance. The purpose of this paper is to describe my observations of this behavior in three North American heron species, and to give several examples of apparent "footedness" (i.e., preference for one foot while foot-stirring) in these same species. My observations concern the Snowy Egret (*Leucophoyx thula*), Reddish Egret (*Dichromanassa rufescens*), and the Louisiana Heron (*Hydranassa tricolor*). All three species were observed in Florida Bay and around the Laguna de la Joyas, near Puerto Arista, Chiapas, Mexico. Additional observations of the Snowy Egret were made on Rulers Bar Hassock, Jamaica Bay, western Long Island, New York, and near Tehuantepec, Oaxaca, Mexico.

USE OF THE FEET

Snowy Egret.—In Florida Bay, the clearness of the water and the relative tameness of this species offered exceptional opportunities to see the feet during this behavior. The whole body, particularly the extended leg, vibrates, and these movements seem to impart a stirring motion to the foot. Usually the bird stirs the substrate, but on several occasions I could clearly see individual birds stir the foot above the surface of the mud, not in it. The bright yellow toes of *thula* are sharply set off from the black legs, and when one of these egrets stirs above the substrate, I get the impression that it is using its foot as a lure.

Stirring is probably the best description of the motion of the foot, but at times N. B. Moore's term "raking" is more appropriate (Baird *et al.*, 1884). When raking, Snowy Egrets extend one leg, then rake the substrate by short, rapid movements of the toes. I saw that this species usually rakes mud, but it tends to stir aquatic vegetation. For example, while using this feeding method on the shallow reefs near Cowpens Cut in Florida Bay, several Snowy Egrets concentrated on stirring tufts of turtle grass (*Thalassia*). When a fish darted from one tuft to another, the egret peered at the tuft, stirred it until the fish moved again, then repeated this procedure until it made a successful strike or moved to a new location. Stirring tufts of turtle grass by *thula* resembles the weed-stirring of the Reef Heron (*Demigretta schistacea*) seen by Hartley (Gibb and Hartley, 1957).

However, when feeding in the shallow muds of Dove Creek slough on Key Largo, Florida, Snowy Egrets tended to rake more than stir. Perhaps different

kinds of prey are taken by stirring and raking; however, fish is the only food I have seen Snowy Egrets secure by either method.

The usual movements made by a Snowy Egret foot-stirring are "stir-peer-stab" or "stir-stab." However, one bird stirred continuously for about one minute, then it twirled about with open wings as it chased several fish forced to move by the egret's activities. Another individual raked the mud of Dove Creek slough until an area of about 100 square feet had been roiled, then the bird ran through the muddied water with open wings, stabbing to the right and left at the harried fish.

The Snowy Egret also shows an interesting aerial variant of this feeding method that I call "hovering-stirring." Sprunt (1936) saw a Snowy Egret hover and pat the surface of the water, while Bond (1934) and Grimes (1936) both observed *thula* feed on the wing. N. B. Moore (Baird *et al., op. cit.*) saw a flock of Snowy Egrets feed by hovering over a shoal of minnows, but apparently none of these authors saw the egrets stir the water while feeding. My observations of hovering-stirring were made in Florida Bay, and typically the feeding egret hovered over one spot, dangled one or both legs, then stirred a tuft of grass or some debris until the prey was forced to move. The strike was always made from the hovering position.

"Foot paddling," in which the legs and feet are moved rapidly up and down on the substrate, has been recorded for *Leucophoyx thula* and *Egretta garzetta* in the Amsterdam Zoo by Portielje (1928). This behavior is very similar to the paddling of many gulls and waders (see discussion in Tinbergen, 1953). I have seen paddling in *thula* on one occasion (Rulers Bar Hassock, May 15, 1954). A single Snowy Egret was stirring in the manner described, when suddenly it stopped, paddled vigorously for about 20 seconds, then resumed stirring. The paddling movements were clearly distinct from those used in stirring.

Reddish Egret.—The foot-stirring of this species differs from that of the Snowy Egret in the following ways: 1) *rufescens* does not extend its leg forward and vibrate it, but simply vibrates its feet as it wades forward in a normal manner; 2) the foot is not moved in a stirring motion but rather it is scraped or raked over the surface of the mud; and 3) *rufescens* scrapes both mud and aquatic vegetation, even when hovering (see below). N. B. Moore (Baird *et al., op. cit.*), commenting on the scraping behavior of *rufescens*, states that "It is a mode peculiar to this species, and not to be mistaken for that of any other."

Motion pictures I took of one Reddish Egret using this feeding method clearly show the scraping movements so typical of this species. The foot is moved rapidly back and forth as the bird slowly wades forward, and the toes appear to scrape or rake the substrate. Of the many Reddish Egrets I have watched using this method, none made stirring movements.

When scraping, *rufescens* almost always uses the technique "scrape-peer-stab." Typically, the feeding bird wades forward slowly, scraping as it goes, then it stops and peers intently at the surface of the water, and then it either stabs at some prey or moves on, usually resuming the scraping movements. As mentioned, in areas where tufts of aquatic grass abound, Reddish Egrets move these plants in search of prey by scraping, not stirring.

This species also shows the aerial variant "hovering-scraping." When hovering over the water, *rufescens* is an extremely agile, graceful species as it moves effortlessly from tuft to tuft. The legs of the bird are dangled, and the plants are agitated by scraping motions of the feet. As with the Snowy Egret, *rufescens* strikes from the hovering position. Although quantitative evidence is lacking, I believe that *rufescens* uses the hovering method more frequently than *thula*.

Louisiana Heron.—This species resembles the Snowy Egret in that it extends one leg and foot forward and then vibrates it rapidly, thus imparting a stirring motion to the foot. I have never seen tuft-stirring in *tricolor*, but I did observe that this species always stirs mud, unlike *thula*, which may stir or rake it. I have never seen hovering-stirring in *tricolor*.

McIlhenny (1936) claims that the Louisiana Heron uses foot-stirring during the winter only, "when the water is cold and their food supply inactive." This was not the case in the winter of 1955–56 in Florida Bay. All of the stirring observations I made of *tricolor* were recorded during warm periods, and I was able to see the tiny fish the herons were preying upon moving about quite actively. For example, the air temperature at Cowpens Cut on April 6, 1956, at 1130 hours was 85 degrees F., and the fish sought by the herons were constantly moving about my boat. On this date I watched a Louisiana Heron foot-stir for three minutes.

Duration of Foot-stirring

Of the three species I have watched, the Snowy Egret uses foot-stirring as a feeding method more often and for longer periods than the other two. N. B. Moore (Baird *et al.*, *op. cit.*) also observed that *thula* uses this technique more frequently than *tricolor* and *rufescens*. Table 1 was made by selecting comparable observations from my field notes. Only those records made of all three species using foot-stirring feeding behavior on the same day in the same place are listed. One bird only was watched during the entire period of observation, and the duration of foot-stirring was recorded with a stopwatch. A glance at Table 1 shows that the Snowy Egret uses foot-stirring for longer periods than do the Reddish Egret and the Louisiana Heron.

Table 2 lists observations of foot-stirring in these same three species that are not comparable as to day, place, and so on, but the data support my belief that Snowy Egrets use this feeding method more often and for longer periods than the other two species.

The few records I have of feeding success while using foot-stirring (see Tables 1 and 2) show that the method is effective. N. B. Moore (*op. cit.*) watched a flock of 70 Snowy Egrets on February 18, 1873, and "scarcely one of this species obtained food without raking for it, numbers being thus engaged at the same time." All of the successful strikes listed in the tables were made on small fish.

TABLE 1

DURATION OF FOOT-STIRRING AND FEEDING SUCCESS IN THREE SPECIES OF HERONS

Species		Place and date			
		Florida Bay			Chiapas, Mexico
		December 16, 1955	March 11, 1956	March 12, 1956	June 24, 1956
Leucophoyx thula	Period[1]	63	27	19	17
	Duration[2]	13	26	15	12
	Success[3]	3/10	5/9	2/17	1/5
Dichromanassa rufescens	Period	150	41	75	8
	Duration	2	3	4	2
	Success	1/4	1/8	1/11	0/0
Hydranassa tricolor	Period	35	57	83	6
	Duration	1	2	1	1
	Success	0/0	0/3	1/1	0/0

[1] Total period of observation in minutes.
[2] Duration of foot-stirring in minutes.
[3] Number of successful strikes/total strikes while foot-stirring.

TABLE 2

FREQUENCY AND DURATION OF FOOT-STIRRING AND FEEDING SUCCESS IN THREE SPECIES OF HERONS[1]

Species	Number of observations	Total observation period in minutes	Total duration of foot-stirring in minutes	Strike success[2]
Leucophoyx thula	10	319	87	17/62
Dichromanassa rufescens	5	470	10	4/23
Hydranassa tricolor	4	120	8	4/17

[1] All of the separate observational periods are combined, as are the duration of foot-stirring and strike success.
[2] Number of successful strikes/total strikes while foot-stirring.

Footedness

I have the following four records of footedness in herons while using foot-stirring feeding behavior: Snowy Egret, 2 (both right); Reddish Egret, 1 (right); and Louisiana Heron, 1 (left). All four individuals used the foot indicated for the entire duration of foot-stirring. These clear cut preferences differ from Hartley's (Gibb and Hartley, 1957) observation of a Reef Heron that used "either foot, but the right more often than the left, to stir tufts of weed to bolt small fishes." Some Snowy Egrets I watched seemed to "lean" toward the use of one foot during an extended period of foot-stirring, but none of these birds was as clear cut in its preference as those cited.

Foot-stirring in Other Herons

I found many references to the foot-stirring feeding behavior of various herons, but Rand (1956) mentions only *thula* and *tricolor*. Prior to my own observations of *rufescens*, only those of N. B. Moore (Baird *et al.*, *op. cit.*) appear to have been available for this species. However, a number of observations of this feeding method have been made in several Old World species of herons. Hartley's record for the Reef Heron has been mentioned, while White (1946), Hopkins (1948), Koenig (1952), and Hobbs (1957) have seen foot-stirring in the Little Egret (*Egretta garzetta*). In Australia, Hopkins (1948) saw this feeding method in the Pied Heron (*Notophoyx picata*), and Hobbs (1957) observed foot-stirring in the White-faced Heron (*Notophoyx novaehollandiae*).

I have never seen foot-stirring in the Common Egret (*Casmerodius albus*), and several authors comment on the absence of foot-stirring in this species (e.g., Rand, 1956; Hobbs, 1957). However, Bagg and Eliot (1937), citing the observation of F. A. Stebbins and A. M. Bowen, state that "the Egret [i.e., *albus*] waded deeper, and when on a muddy bottom would, with the aid of his wings, hop straight up clear of the water and come down with stiff, spread toes, and then scrutinized the 'roil' he had caused for dislodged prey. He swallowed several fish." Although it is not foot-stirring, this observation suggests that some herons may effectively secure food by a feeding method using the legs and feet to disturb the prey without recourse to stirring or scraping.

Discussion

The bright yellow toes of *thula* and *garzetta* are sharply set off from the black legs, and both species use foot-stirring feeding methods. This distinctive pattern suggests that it may have evolved in conjunction with this peculiar feeding technique. However, the feet of *thula* turn a brilliant coral orange during the early part of the breeding season, and the feet are conspicuously displayed at this time (Meyerriecks, 1958). In addition, the feet of *garzetta* become crimson-pink during the breeding season (Henry, 1955), but the displays of

the Little Egret are not known in detail. It is possible that the feeding function of this pattern is primary and the display function secondary; however, both functions will reinforce the selection of bright feet. More information on the frequency and duration of foot-stirring in herons is needed before any conclusions can be made.

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DISPLAY BEHAVIOR OF BUFFLEHEAD, SCOTERS AND GOLDENEYES AT COPULATION

BY M. T. MYRES

THE displays which occur in connection with the mating act have been described in but a few species of birds, and in fewer still has any attempt been made to relate these to, or distinguish them from, the other courtship displays. In a recent study (Myres, M. T., 1957 MS. An introduction to the behaviour of the goldeneyes: *Bucephala islandica* and *B. clangula*. M.A. Thesis, University of British Columbia) it was shown that the pre- and post-copulatory displays of Barrow's Goldeneye were almost indistinguishable from those of the Common Goldeneye. This was in marked contrast to those courtship displays which have a primarily pair-forming and pair-maintaining function, which were remarkably different in the two species. It is therefore of considerable interest to make further comparisons in the displays connected with copulation between other species of sea ducks (tribe Mergini* of the family Anatidae). Such a comparison is presented here between the only other member of the genus *Bucephala* (*B. albeola*, the Bufflehead) and the two species of goldeneye already mentioned, and between two species of the genus *Melanitta* (*M. deglandi*, the White-winged Scoter, and *M. perspicillata*, the Surf Scoter) and the Bufflehead.

During the summer of 1957 I observed copulation of the Bufflehead on 12 occasions on Watson Lake, at 105 Mile, Cariboo Highway, in the Cariboo District of British Columbia. To my knowledge, the actions occurring at copulation have not been described previously for this species. On 103 Mile Lake, two miles away, I observed five instances of copulation in the White-winged Scoter. During the following winter, 1957–58, I saw copulation of the Surf Scoter on four occasions on salt water off Saltspring Island, B. C. The displays observed will be described for each species below, but a few remarks should be made regarding the manner of presentation.

Capitalized words are names allotted to distinct displays. In a few instances names are given to displays, described elsewhere, of other species. To prevent unintended homologization of displays between species, different names are employed wherever possible, except when it is believed that two displays are without any doubt homologous. It will become clear in the course of the discussion which displays, of the species described here, I believe to have had common origins. There may be instances where a name has been used, unavoidably, which is also used for a display in another species not discussed here. In such instances no homology should be understood, unless it has been clearly mentioned.

* Classification follows P. Scott, **Key to the Wildfowl of the World.** Severn Wildfowl Trust, Slimbridge, Gloucestershire, England. Revised, 1951.

In a few places it is stated that one display is more, or less, common than another. Because the number of separate copulations observed is only 21, and only one or two of these were recorded quantitatively by describing them onto magnetic tape, these assertions are not strictly objective. Rather they are subjective impressions received while watching the copulation sequence, in particular the course of the pre-copulatory display behavior.

Bufflehead

Copulation was observed 12 times between May 31 and June 16, 1957, as follows: May 31 (twice), June 1, 2, 3, 4 (three times), 5 (twice), 14 and 16. Most frequently the performance took place between 8:00 a.m. and midday, but on three of the 12 occasions it was seen in the evening. By June 16 many broods of downies were already on the lake, and I estimated that about half the broods subsequently present were there by that date. It is evident, for this and other reasons, that the females with whom males were seen to copulate were already well ahead with the incubation of their clutches by the first day in June.

The female assumes a flattened pose on the water (Prone-posture), but it is unusual for the female to assume this for more than a few moments before the male mounts (this is in contrast to the two goldeneyes where the female may remain in the Prone-posture for as long as 20 minutes).

The male swims around the female, or rests close by her on the water, performing the two main pre-copulatory displays. These are (1) a twitching of the water with his bill (Water-twitch), and (2) a preening movement over his back (Preen-dorsally):

1. The Water-twitch consists of dipping the bill to the water and then a slight sideways movement of the head, which is almost indistinguishable from a similar comfort movement. The movements may be distinctly separated by a pause, or by a Preen-dorsally, or they may be repeated one after the other in fairly quick succession.

2. In the Preen-dorsally it is impossible to be certain that the wing has been lifted in any way on some occasions, and indeed it probably is not lifted on all occasions. The bill must then come into contact with the feathers of the back or the upper side of the folded wing. On other occasions the wing is seen to be only slightly raised, and on one occasion the long scapulars were seen to be lifted more than the carpal joint so that a tiny spot of white appeared (from the secondary feathers or coverts). More often, however, the movement of the wing was just the lifting of a black shape above the back. In the Preen-dorsally the head may be swung around through an arc on the side toward the female, or on the side away from her. It seems likely that the indefinite lifting of the wing, and the variability as to which wing is concerned, may be an indication that the display is not as ritualized as in the surface-feeding ducks in which the colored speculum is flashed during this display—presumably most often in the wing which faces the female. K. Lorenz (1941. *Jour. f. Ornithol.*, 89:194–294) states that in *Aix galericulata* this is invariably so in the Mock-preening display.

In the Bufflehead the Preen-dorsally is closely linked with the Water-twitch, and the latter generally occurs before the former, just as a bird performing

comfort-preening frequently dips his bill into the water in front of him. Undoubtedly the two displays originate from this comfort movement sequence. In the Bufflehead it was observed, however, that Water-twitching was more frequent than the Preen-dorsally (contrast White-winged Scoter).

The unritualized form of these displays is also indicated by the fact that in the goldeneyes the supposed homologues of these movements (Jabbing and Wing-preen) are very highly ritualized: the Jabbing or Water-flicking of the goldeneyes is a frenzied series of movements and the Wing-preen is brief and momentary. Also in the goldeneyes they occur in a fixed sequence leading into the motor pattern of mounting itself—the Wing-preen never occurs, in fact, except as a preliminary motion at the beginning of the Steaming movement which, in goldeneyes, brings the male onto the back of the female.

After a few moments, or a minute or two, of Water-twitch and Preen-dorsally display activity (the frequency of repetition is variable), the male suddenly moves toward the female and mounts. Generally he begins to move toward her from only a foot or so away, and the locomotory performance is not spectacular, but on one occasion it seemed that he made a slight rush over the water. On three occasions, out of eight in which the complete copulation sequence was observed, the wings were momentarily lifted off the back (Wing-flick) and snapped back into place about the time of intromission. This action has also been observed in goldeneyes and scoters. The tail is waggled from side to side during copulation.

On dismounting the male continues to hold onto the head of the female with his bill, and the male and female rotate around each other for one or two full turns (Rotations). On three occasions, out of the 12, it appeared that the female was almost turned over onto her back as the male pulled at her head during the Rotations, and one of her legs was seen thrashing above the water behind her.

As soon as he releases the female, the male almost at once begins to dip his head and the forepart of his body below the water, and to shimmer his wings in the water, as in normal comfort bathing (Bathing). The female also acts similarly, and then both birds stretch upward out of the water (Upward-stretch) and flap their wings (Wing-flap), in a fashion identical with the comfort movements. However, this was only seen to occur on four of the 12 occasions. Twice the male made a shallow plunge below the surface first, as if the movement were an exaggeration of the first dip of the Bathing behavior. On no less than six occasions the male dived deeply (Plunge) coming up from one to 15 feet away from the point of diving. On four of these last occasions the male performed the Upward-stretch and Wing-flap immediately on surfacing without prior Bathing, in another instance he performed Bathing, and in the sixth his actions were not recorded. On one of these six occasions the Upward-stretch and Wing-flap were followed by more Bathing. In two of the

12 instances the female, after she had performed some comfort movements at the end of copulation, performed a few of the neck-stretching and crouching movements which she generally performs when following a particular male away from a strange male or males (Following).

On two occasions the first attempt at mounting did not result in a successful ejaculation, because the male slipped off the back of the female and performed Water-twitching movements again before mounting again. In one of these cases three attempts were made to mount in succession, and in another case the male appeared to give three Water-twitching movements, followed by a single Preen-dorsally, while actually mounted on the back of the female. No Rotations were observed, nor did the male Plunge, after this but he did perform Bathing. The absence of the customary Rotations probably indicates failure to effect ejaculation, because in an unsuccessful copulation in *Bucephala islandica* the post-copulatory Rotations and Steaming displays were absent and the failure was followed by more pre-copulatory display actions, a successful copulation, and finally the normal post-copulatory displays (Myres, *op. cit.*).

White-winged Scoter

Copulation was observed on five occasions: May 31 (once), June 2 (twice in succession), June 3 and 5 (once each). At this period many of the pairs (of which there were about 15 present on 103 Mile lake), were not, apparently, incubating their eggs. They may also have been nonbreeding birds.

The female assumes the Prone-posture from a position in which the head is elevated and forward, as in the "alarm" posture of this species. However, the Prone-posture is assumed only just before the male mounts. On three of the five occasions on which copulation was observed the female suddenly stretched her neck rigidly upward at an angle of 45 degrees forward as soon as the male caught hold of her head feathers on mounting. The same posture was observed when the female reappeared above the water after copulation.

Three displays were observed in the male prior to copulation: (1) False-drinking, (2) Water-twitch, and (3) a Preen-behind-the-wing display (which is presumably the homologue of Preen-dorsally in Buffleheads). It should be mentioned here that during the winter of 1957–58 courtship behavior of this species was watched on a number of occasions. The main elements were the same as in the pre-copulatory behavior (namely the three displays mentioned above). This is the *only* species, of the ones reviewed here, in which this equivalence has been found. In the goldeneyes, Bufflehead and Surf Scoter the courtship displays of the pair-forming and pair-maintaining series differ quite markedly from the pre-copulatory displays.

1. False-drinking was performed by the male alone, or mutually by both male and female when it may be repeated a number of times. The display consists of dipping the bill to the water in front of the bird and a sudden elastic elongation of the neck forward and upward at an angle of about 75–80 degrees, until it is fully stretched and the head and neck appear to be larger than the rest of the body. The neck relaxes and shortens, more slowly, immediately afterward. In the final stages of the pre-copulatory behavior, the False-drinking display may sometimes be less common than it is in the courtship behavior, this

was not consistently the case.

2. The Water-twitch was a dipping of the bill to the water, but with only a slight shake of the head. Generally the head was immediately lifted and swung round to the side, through 170 degrees, to the middle of the back and the Preen-behind-the-wing took place. The Preen-behind-the-wing was sometimes more common than the Water-twitch (contrast Bufflehead), but whenever the Water-twitch occurred it appeared always to be followed by a Preen-behind-the-wing.

3. The Preen-behind-the-wing takes three forms: (a) the scapulars and secondaries are lifted and held up for some movements which also exposes the white speculum, distinctive of this scoter. The preening movement may take place with the wing on the side toward the female, or on the side away from her. It often occurs when the male is some distance from the female; (b) the bill is thrust along the side of the body, or into the shoulder feathers, and the pink bill is then clearly visible against the black body plumage as the preening movement is made; and (c) the back feathers are nibbled. The white iris and white feathers around the eye are also most striking in both (b) and (c).

Eventually the male mounts the female, but there is a considerable period between the time the male covers the female and the Wing-flick. This movement was observed to occur once (or twice) in all five of the copulations observed. It was a vigorous movement, and made a sound as the wings beat the water. Upon dismounting, on two occasions the male was just holding on to the head of the female, but only a fraction of a circle (perhaps 20–30 degrees) was rotated. There was no post-copulatory display (contrast Surf Scoter), except that the male (upon slipping back into the water) flicked the tips of the primaries to rearrange the wings. The male was then in a hunched posture and drifted or swam slowly away from the female. The female also rearranged her wings.

Surf Scoter

Copulation was observed on four occasions in midwinter on the sea off Saltspring Island, B. C.: December 29, 1957 (once), January 3, 1958 (twice in midafternoon) and January 5, 1958 (once in the afternoon). On all occasions there is no evidence to indicate that the birds involved were permanently paired. It would appear, by comparison with copulations of the White-winged Scoter observed on the breeding grounds, that the complete copulation display sequence was observed, despite the time of year.

The Prone-posture resembles that of the goldeneye. The female lies flat with the neck below the water, and the bill curved upward. The longest time this was held was about two minutes in one of the copulations.

The displays involved were extremely similar to those observed at copulation of the White-winged Scoter. The main pre-copulatory displays were the Water-twitch and the Preen-behind-the-wing, though these were not described in detail, while False-drinking was also observed.

The male mounted the female slowly, as in the White-winged Scoter, and in every case the wings were eventually flicked, but the movement was a single Wing-flick, not a double one. Upon dismounting, however, there was

a display not observed in the White-winged Scoter. This display (Chest-lifting) was seen on all four occasions as follows:

As soon as the male slipped back into the water he threw his head back until it was over the middle of his back, which developed a 45 degree slope, and he thrust out his chest. Chest-lifting greatly resembles a display which is seen in a courting party. It is a sudden and brief movement. After Chest-lifting, no other movements by the male were observed. In one case the female did some unidentified movements afterwards, and then did the Upward-stretch and Wing-flap.

There were unusual features about two of the copulations observed: (a) the third copulation occurred only a few minutes after the second, though it is not certain that the same male was involved in each case. The time was around 3:00 p.m. It was very mild, and drizzling at the time. A small party of Surf Scoters broke up, leaving two females and a male. The two females were tilting their bills upward repeatedly without lifting their heads, as in the Chin-lifting of Lesser Scaup (*Aythya affinis*). The male, between them, was performing the display in which he lifts the head and makes a scooping movement across the chest. The male also performed Water-twitches and Preens-behind-the-wing. Then he did some violent dipping, of the Bathing sequence, and one of the females assumed the Prone-posture. The male mounted her and copulation proceeded although the other female was almost touching them. (b) In the fourth and last copulation, the male mounted the female from in front, over her head. She quickly swung around beneath him, but there was (as usual) a considerable pause before he seized her head feathers.

Discussion

The displays occurring in the copulation sequence of the two genera *Bucephala* and *Melanitta* are listed and compared in Table 1. The pre-copulatory displays of the male Bufflehead consist of twitching the water with the bill, and making a preening-type movement in the dorsal region between the wings. Similar displays occur in the two scoters studied. In the two goldeneyes, by contrast, the predominant pre-copulatory displays of the male are stretching the wing and leg, and flipping water into the air with the bill. As I was more familiar with the goldeneyes I was not at first sensitive to the fact that Water-twitches and Preening-dorsally were indicative of copulation behavior in the Bufflehead.

It seems to be significant that in Buffleheads the Water-twitch movement may be more frequent than the dorsal preening movement, whereas in the White-winged Scoter the preening movement is the more frequent pre-copulatory display. Whenever the Water-twitch did occur in the scoter it was generally followed immediately by a Preen-behind-the-wing. The twitching of the water with the bill before preening is, of course, a normal part of a comfort movement sequence in diving ducks, and it is most interesting that *M. deglandi* and *B. albeola* have diverged in the relative frequency with which they use these two movements in display. I find that Lorenz (*op. cit.*) also noted instances of variously ritualized linkages of two displays of the general courtship sequence

in some other ducks. In the Wood Duck (*Aix sponsa*) and the Mandarin Duck (*Aix galericulata*) of the tribe Cairinini, for example, the Mock-preening display never occurs without the preceding "drinking" movement. In the Wood Duck "drinking" may occur at lower intensity by itself, but in the Mandarin Duck the two displays are absolutely linked. In the Gadwall (*Anas strepera*) Lorenz found, furthermore, that the two displays are equally firmly linked, but in the reverse order (Mock-preening is followed by "drinking").

TABLE 1

DISTRIBUTION OF MALE COPULATORY DISPLAYS IN *MELANITTA* AND *BUCEPHALA*[1]

M. perspicillata	*M. deglandi*	*B. albeola*	*B. islandica* *B. clangula*
Pre-copulatory			
False-drinking	False-drinking	———	**Water-flip**[2]
———	———	———	**Wing- and Leg-stretch**
Water-twitch	Water-twitch	**Water-twitch**	Note[2]
Preen-behind-wing	**Preen-behind-wing**	Preen-dorsally[2]	Note[2]
Mounting			
———	———	———	Water-flick (and Jabbing)[2]
———	———	———	Wing-preen[2]
———	———	———	Steaming
Single Wing-flick	Double Wing-flick	Wing-flick(?)	Wing-flick
Post-copulatory			
———	———	Rotations	Rotations
Chest-lifting	———	———	Steaming
———	———	Plunge or Bathing	Bathing
?	Rearrangement-of-wings[3]	Upward-stretch and Wing-flap[3]	Upward-stretch and Wing-flap[3]

[1] The displays in boldface are the most frequent displays in each species.
[2] It should not be taken as certain that any of these displays are homologous until analytical ethological work has been conducted, but in the discussion it has been assumed that Water-twitch, Water-flick and Jabbing may be the same; that False-drinking and Water-flip are the same; and that Preen-behind-the-wing, Preen-dorsally and Wing-preen are the same.
[3] Generally this is followed by a Tail-wag, but this was not specifically noted in these displays, though it probably occurred. The Rearrangement-of-wings of **M. deglandi** may represent the settling of the wings after the Wing-flap which generally coincides with the Tail-wag.

Preen-dorsally, or Preen-behind-the-wing, may well be homologous with the Mock-preening movements found in the general courtship displays of *Aix* and *Anas*, in which a colored speculum has been evolved, which emphasizes this ("morphological reinforcement"), and other movements (Lorenz, *op. cit.*; Tinbergen, N., 1952. *Quart. Rev. Biol.* 27: 24 and 27). In *Anas discors*, *A. cyanoptera*, *A. querquedula* and *A. clypeata* there is a further development. The secondary coverts are pale blue, and Lorenz (*op. cit.*) states that in *A. querquedula* the preening movement takes place on the outside (instead of the inside) of the wing, and that the bill is actually directed at these coverts

rather than the speculum. In only one of the three scoters are the secondaries differentiated and at variance in color from the rest of the black plumage of the wing. But display-preening is not absent in the two scoters studied merely because of this. Instead of plumage differentiation we find that the scoters have brightly colored bills (bright pink; white, orange and black; pale yellow or orange). It seems certain that the colored bill must be an alternative method of emphasizing the display movement. It really matters very little, so far as producing additional sign stimulation is concerned, whether this is done by preening *specula* (or *coverts*) which are colored, or by a *bill* (colored) preening a uniformly dull wing.

The Water-twitch of the Bufflehead is probably homologous with the Jabbing display of *B. clangula* or the Water-flicking behavior of *B. islandica* (Myres, *op. cit.*) which also occur in the pre-copulatory sequences. Jabbing in *B. clangula* immediately precedes the momentary Wing-preen display before mounting. But the Water-twitching movement of *B. albeola* was never a group of frenzied Jabbings as it is in *B. clangula*. The Wing-preen display of the goldeneyes is very rapid and, as a display, occurs only in the pre-coition sequence: in *B. clangula* it is a single momentary movement just as the pre-coition Steaming posture is assumed. In the Bufflehead and White-winged Scoter the movement is not unusually rapid, and so appears less ritualized. No False-drinking, Wing- or Leg-stretching, or Steaming movements were observed in the pre-copulatory behavior of the Bufflehead. But False-drinking (comparable to Water-flip of the goldeneyes) occurs in the pre-copulatory display of the White-winged Scoter, though rather less frequently than the Preen-behind-the-wing or the Water-twitch.

The post-copulatory displays are also interesting. Rotations do not occur in the White-winged or Surf Scoters at all. In the two goldeneyes they do not appear to differ at all from the Rotatory movements of Buffleheads. It is not clear to me yet which of the two sexes is providing the propulsive thrust, and which the drag, which results in circling of both birds over one spot.

The pre-and post-copulatory Steaming displays of the two goldeneyes appear to be completely absent from *B. albeola* and the two scoters. In the Bufflehead a deep dive (Plunge) occurs on some occasions, which would appear to be an exaggeration of the preliminary plunges or dips which accompany Bathing. Bathing always occurs after copulation in the two goldeneyes, as well as in the Bufflehead, but in the latter species was omitted when the Plunge occurred. The Plunge was followed directly by the Upward-stretch and Wing-flap. Bathing and even the Upward-stretch and Wing-flap were absent in the post-copulatory sequence of the two scoters, and the only comfort action was a flicking of the tips of the primaries (Rearrangement-of-wings), which is possibly homologous with the final motions of closing the wings after the Wing-flap which completes the sequence in *Bucephala*. The only way in

which the Surf Scoter differs in copulatory behavior, qualitatively, from the White-winged Scoter is in having a distinct post-copulatory display (Chest-lifting).

Whereas in the goldeneyes the female may be in the Prone-posture for a considerable time (as long as 20 minutes), in the Bufflehead and Surf Scoter the Prone-posture is assumed only a short while before the male mounts, and in the White-winged Scoter was observed only immediately prior to mounting, or as the male trod the female. There may be a correlation between the duration of soliciting by the female and the number and variety of displays in the male, e.g., the most are found in the long-soliciting goldeneyes, and the fewest in the White-winged Scoter. In the Bufflehead there were a few suggestions that, while mounted, the wings of the male were flicked. In goldeneyes the Wing-flick is a regular accompaniment of intromission. In all five instances of copulation in the White-winged Scoter a double Wing-flick was noted, and in all four instances a single Wing-flick was seen in the Surf Scoter.

A major theoretical interest of the pre- and post-copulatory behavior of the ducks under discussion is that the displays involved are generally confined to the moments just before, and just after, the act of mating. They are generally confined to this moment in the reproductive cycle, and are rare in the more frequently described courtship behavior. Thus the Head-bobbing of the Bufflehead, which is the most well-known display of the male of that species, is absent completely from the copulation sequence. This rule applies fairly well also in the two goldeneyes. The Headthrow of *B. clangula* and Rotary-pumping of *B. islandica*, which are respectively the most frequently observed displays of these species, occur infrequently in the pre-copulatory behavior. In *B. islandica* it is possible to watch the Rotary-pumping display give way as the time for coitus approaches, to Water-flips and the Wing- and Leg-stretching displays indicative, in the male, of copulation.

Ethologists are asked to realize the importance of the displays associated with copulation. These displays prove to be, in ducks, more conservative than the general courtship displays with pair-forming and pair-maintaining function. The copulation sequence may thus be of considerable importance in studies of the taxonomic relationships of species and genera. Thus, taking all displays into account, it is very hard to place the Bufflehead in the family tree, but considering only the displays of the copulation sequence it appears to be intermediate between the scoters and the goldeneyes. A much clearer picture will be established when descriptions of coitus are available for the other ducks comprising the tribe Mergini.

Another interest of the displays occurring at copulation lies in the light they may throw on the *successive* evolution of courtship displays within a differentiating stock of animals. In the present case the developmental status of the Jabbing and Wing-preen displays of the Common Goldeneye, on the one hand,

and the Mock-preening of *Anas* and *Aix* on the other, appears uncertain. The Water-twitch and Preen-dorsally, or Preen-behind-the-wing, displays appear less ritualized than either, but the direction in which evolution may have proceeded in regard to these displays is not yet clear. A comparative review of the evolution of courtship *versus* the copulation displays is planned.

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Summary

The copulation of *Bucephala albeola* was observed 12 times, of *Melanitta deglandi* five times, and of *M. perspicillata* four times. The displays and actions employed are compared with those occurring at copulation in the two goldeneyes (*Bucephala* spp.). The Wing- and Leg-stretch display of the latter was completely absent from *B. albeola* and *M. deglandi*, in which the Water-twitch and the Preen-behind-the-wing predominated. Both these movements occur in association, however, in the normal comfort-preening sequence of ducks, and in similar (? non-homologous) Mock-preening displays in the general courtship displays of members of both the Anatini and Cairinini. In the copulation behavior of goldeneyes they occur only in a momentary form just immediately prior to the exaggerated Steaming display which constitutes the approach to the female at mounting in these species. The post-copulatory Rotations, alone of all the displays, take exactly the same form in all three species of *Bucephala*. Rotations were not observed in scoters and the only difference between the two scoters in the displays occurring at copulation was in the existence of a Chest-lifting display after coitus in the Surf Scoter. The post-copulatory Steaming of the goldeneyes is replaced in *B. albeola* by a Plunge movement on some occasions. This may be an exaggerated prelude to the bathing that occurs after coitus. Scoters lack Steaming displays and the White-winged Scoter merely rearranges the wings after dismounting.

Ethologists, it is suggested, should pay more attention to the comparative aspects of copulation displays, since they are probably conservative. Taken with other differences in display between *B. albeola* and the goldeneyes, the possibility exists that *B. albeola* should not be placed in the same genus as the goldeneyes. The evolution of morphological reinforcement of the sign stimulatory effects of motor patterns of display is discussed in reference to the speculum of ducks in general, and to the colored bills of scoters in particular.

Department of Zoology, University of British Columbia, Vancouver, British Columbia, February 8, 1958

FOOD HABITS OF NESTING COOPER'S HAWKS AND GOSHAWKS IN NEW YORK AND PENNSYLVANIA

BY HEINZ MENG

MUCH has been written about the food habits of our birds of prey. Through crop and stomach content analyses it has been shown that most hawks and owls are beneficial to man's interests and, therefore, are protected by many states. However, there is a notable exception—the accipiters. In only eight states are the accipiters fully protected. Five other states protect them except when they do damage to poultry, livestock, etc. Food habit studies always indicate that the large accipiters—the Cooper's Hawk (*Accipiter cooperii*) and the Goshawk (*Accipiter gentilis*)—feed largely on poultry and game and, therefore, are unprotected.

Accipiters are exceedingly wary, woods hawks and are seldom seen even in areas where they are abundant. Cooper's Hawks and Goshawks are fast fliers and are seldom shot by hunters. The great majority of specimens available for food habit studies, therefore, come from game farms where they are caught in pole traps. Most of these hawks are young birds which have been attracted by the concentrations of game or poultry. Occasionally accipiters (as well as buteos) are shot from "kills" which prove to have been previously crippled or wounded game birds (McDowell and Luttringer, 1948). Analyses of the crop and stomach contents of this rather select group of hawks will naturally indicate a high percentage of poultry and game birds in their diet.

Probably the best way to secure information about these hawks is to study their feeding habits during the nesting season. Nests are located early in the spring and studied throughout the breeding season. For the past ten years I have studied the food habits of nesting Cooper's Hawks and Goshawks in New York and Pennsylvania. Pellets and remains of prey found in the nests and nest areas were collected and analyzed. Data were secured from 34 Cooper's Hawk nests and 14 Goshawk nests.

During the first three years of this period (1948–1950) a study was made of the food consumed by 12 broods of Cooper's Hawks. Each nest was visited four or five times a day from the hatching date until the hawks had left the nests. All of the pellets and remains of prey were collected and analyzed. Pellets found during one day were combined with the data of quarries observed in the nest on the previous day, in order to determine not only what species were preyed upon but also how many of each. Table 1 shows the kind and number of food items consumed by 42 young Cooper's Hawks at 12 nests in the Ithaca, N.Y., region.

In the Ithaca region the food of growing Cooper's Hawks, as well as of the adults who partake of the prey brought to the young, consists of 18 per cent mammals and 82 per cent birds. The most important prey mammals are the

TABLE 1

FOOD OF YOUNG COOPER'S HAWKS AT ITHACA, NEW YORK

Species		Number
Birds		
Ring-necked Pheasant (*Phasianus colchicus*)		4
Spotted Sandpiper (*Actitis macularia*)		1
Rock Dove (*Columba livia*)		13
Mourning Dove (*Zenaidura macroura*)		5
Screech Owl (*Otus asio*)		1
Yellow-shafted Flicker (*Colaptes auratus*)		134
Pileated Woodpecker (*Dryocopus pileatus*)		1
Red-headed Woodpecker (*Melanerpes erythrocephalus*)		1
Yellow-bellied Sapsucker (*Sphyrapicus varius*)		1
Hairy Woodpecker (*Dendrocopos villosus*)		5
Blue Jay (*Cyanocitta cristata*)		11
Catbird (*Dumetella carolinensis*)		1
Robin (*Turdus migratorius*)		79
Wood Thrush (*Hylocichla mustelina*)		7
Starling (*Sturnus vulgaris*)		241
Ovenbird (*Seiurus aurocapillus*)		5
Bobolink (*Dolichonyx oryzivorus*)		1
Eastern Meadowlark (*Sturnella magna*)		118
Redwinged Blackbird (*Agelaius phoeniceus*)		3
Common Grackle (*Quiscalus quiscula*)		37
Brown-headed Cowbird (*Molothrus ater*)		17
Scarlet Tanager (*Piranga olivacea*)		9
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)		1
Rufous-sided Towhee (*Pipilo erythrophthalmus*)		2
TOTALS	24	698
Mammals		
Cottontail (*Sylvilagus floridanus*)		6
Eastern Chipmunk (*Tamias striatus*)		109
Gray Squirrel (*Sciurus carolinensis*)		4
Red Squirrel (*Tamiasciurus hudsonicus*)		36
TOTALS	4	155
TOTALS	28	853

chipmunk and the red squirrel, which together make up 94 per cent of the mammalian diet during the nesting season. The Starling, Yellow-shafted Flicker, E. Meadowlark, Robin, and Common Grackle together constitute 87 per cent of the avian diet, with the Starling being by far the most frequent item on the menu.

L. L. Snyder (1937) examined 40 Cooper's Hawks killed in Ontario during 1931 and 1932 and found Starlings in 17 of them.

In a typical nest containing four young, an average of 266 prey items was brought to the nest during the first six weeks: 4 quarries per day during the first week, 5 per day during the second week, 7 per day throughout the third week, 9 per day during the fourth week, 7 each day during the fifth week and 6 per day in the sixth week. It takes an average of 66 prey items to raise a Cooper's hawk to the age of six weeks. The females are about one-third larger than the males and require more food, so this figure would be slightly higher for the females and lower for the males.

FIG. 1. Cooper's Hawk at nest with young.

Most quarries are young animals that have not yet learned to be sufficiently wary, but occasionally adult birds are also brought in. These are probably caught while protecting their young. Like most predators the Cooper's Hawk will take what is most abundant and easiest to catch. Sometimes even two-thirds-grown nestling birds are taken from their nests. On two occasions I saw a male, who does almost all of the hunting, bring two live nestling Scarlet Tanagers to its nest.

There have been a few reports of Cooper's Hawks taking young chickens during the nesting season, and if an individual male gets into this habit he may cause quite a loss to the owner. However, very few acquire this habit and most hawks tend to specialize on common wild birds or mammals that are available throughout the year. One Cooper's Hawk nest that was studied intensively was within 300 yards of a large poultry range. Thousands of chickens could be seen from the nest, and they were sufficiently small so that the male could have easily killed and brought them to the nest, but not a single one was found in the nest, nor did the owner complain of having lost any. A similar incident in the case of a Goshawk nest in Nova Scotia was reported by A. C. Bent (1937:132–133). The nest was located one-half mile from a poultry yard that produced about 300 chicks. The farmers did not complain of losing a single bird all summer, nor had they seen any "hen hawks" about their premises.

Time did not permit as intensive a study of the 14 Goshawk nests, but some rather interesting data were gathered. Nine of the nests were located in Wayne Co., Pa., three in Potter Co., Pa., and two in Chenango Co., N.Y. Each of the nests was visited several times during the nesting season, and once about a month after the young had left the nest. Pellets and remains of prey were gathered and analyzed (Table 2).

TABLE 2

ANALYSIS OF PELLETS AND PREY REMAINS AT GOSHAWK NESTS

Species		Number of times found
Birds		
Sparrow Hawk (*Falco sparverius*)		3
Ruffed Grouse (*Bonasa umbellus*)		5
Blue Jay (*Cyanocitta cristata*)		7
Common Crow (*Corvus brachyrhynchos*)		83
Blackbird (*Euphagus, Quiscalus, Agelaius*)		15
TOTALS	7	113
Mammals		
Cottontail (*Sylvilagus* sp.)		7
Eastern Chipmunk (*Tamias striatus*)		3
Gray Squirrel (*Sciurus carolinensis*)		4
Red Squirrel (*Tamiasciurus hudsonicus*)		58
TOTALS	4	72
TOTALS	11	185

As can be seen from Table 2 the red squirrel and the Common Crow were the main food items of these 14 nesting pairs of Goshawks. Under one nest 24 crow legs and 15 humeri were found, and at another nest 3 crows were brought to the young while the writer was photographing the hawks from a blind. The remains of grouse were found only five times. The wing and leg bones of large birds are generally not swallowed by the hawks, and they can be found under the nests and in the nest areas. The humeri of crows and grouse are very similar in appearance, and very probably crow humeri have been mistaken for grouse bones in the past. In the area studied, crow humeri average 64 mm. in length and are straighter than grouse humeri, which average 57 mm. in length.

FIG. 2. Goshawk at nest with young.

In all of the Goshawk nest areas studied the grouse population was high, but grouse appeared only five times in contrast to 83 crows. This suggests that the Goshawks do not select a particular area to nest in because of the high grouse population, as is often thought, but that they may even be instrumental in increasing the numbers of grouse by removing numerous crows. Red squirrels, chipmunks, and crows destroy many grouse nests by feeding

on the eggs and young, or, as in the case of the chipmunk, by pushing the eggs out of the nests.

From the above data it can be seen that the Cooper's Hawk and Goshawk are important predators of the Starling, Common Crow, red squirrel, and chipmunk. In view of these data it seems logical that these two accipiters should be protected along with the other birds of prey. Also, as long as even one species of hawk or owl remains unprotected all will continue to be shot. I feel that all birds of prey should be given protection, with the stipulation, as is found in Michigan's law, that "a farmer or landowner may destroy hawks or owls on the land which he owns or occupies, which are doing real damage to poultry or other domestic animals" (Morrison, 1955).

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State University Teachers College, New Paltz, New York, December 16, 1958

NOTES ON THE NESTING OF *TURDUS LEUCOMELAS* IN SURINAM

BY F. HAVERSCHMIDT

THE Grey-headed Thrush (*Turdus leucomelas*) has a vast range in South America from Colombia eastward to the Guianas and southward to southeastern Brazil, Matto Grosso and Perú. The representative in Surinam, *T. l. albiventer*, is confined to Colombia, Venezuela and the region from the Guianas southward to the middle Amazon and Bahia. The upper surface of this thrush is brown, except the head which is dark greyish. The breast, abdomen and sides of the body are grey, the throat being broadly streaked with white. The axillaries and under wing coverts are bright rufous and the eyes are dark red. The sexes are indistinguishable in the field. The weights of specimens collected by me in Surinam are: 10 males, 55 to 76 grams (mean, 68), and 5 females, 67 to 75 grams (mean, 71).

In the coastal region of Surinam this is the commonest thrush, frequenting open forests and coffee plantations. It is now a common garden bird, breeding even in the middle of Paramaribo, but it also occurs in the sandy savannas further into the interior wherever there are scattered bushes or patches of forest. The local name in Surinam is "boontjedief" (= thief of peas). Another thrush in the coastal and savanna area is *Turdus nudigenis* which is found in the same habitat but it is definitely less numerous. Two other species, *T. fumigatus* and *T. albicollis*, are shy forest birds.

Breeding season.—In the Penard Oölogical Collection from Surinam, now preserved in the Leyden Museum, the eggs of *T. leucomelas* are dated January to June, but in my experience the breeding season begins at least two months earlier, in November and December. Thus, nesting seems to be confined to the short rainy season (from mid-November until mid-February), the short dry season (from mid-February until mid-April) and the long rainy season (from mid-April until mid-August). Breeding apparently does not take place in the driest months of the year (August to October) which may be due to the fact that at that time the ground is too hard and dry to provide sufficient food for the nestlings. That breeding does take place in the short dry season is not a contradiction of this rule since there is quite a lot of rain in this period, in most years. In fact, during the last several years this season was extremely wet. Fifteen nests in which incubation was in progress were distributed as follows: November, 1; December, 2; January, 1; February, 1; March, 2; April, 4; May, 4.

From December, 1951, until June, 1952, I was able to observe a pair that nested on a rafter near one of my windows, and which reared four broods in rather quick succession in the same nest. Though the birds were not marked

I am certain that it was the same pair. Their history is as follows:

Brood No. 1. Nest-building started on December 8, 1951. Incubation was seen for the first time on December 18, and feeding the nestlings on January 1, 1952. Two young left the nest on January 16 and one the following day.

Brood No. 2. Repairing of the nest started on January 29. Incubation was seen on February 6, and feeding the nestlings on February 20. Three nestlings left the nest on March 6, 7 and 8, respectively.

Brood No. 3. Repairing of the nest was seen on March 14, and incubation began on March 18. Two young left the nest on April 18 and 19.

Brood No. 4. Repairing of the nest started on April 25. On April 30 it was still empty, but it contained 2 eggs on May 2 and 3 eggs on May 3. The eggs hatched on May 15. Two nestlings left the nest on June 1.

In four broods a total of 10 young was reared.

Nest and nest-building.—In the cultivated area the nest is very often made on rafters under wooden buildings. The nest is a typical thrush nest, and is lined with small, dry roots, therefore resembling the nest of the European Blackbird (*Turdus merula*). I observed only one bird engaged in building, probably the female as is the rule among thrushes.

Eggs.—As most nests are difficult to reach I have no records of clutch size apart from Brood No. 4 (3 eggs), but from the data in the Penard Collection it seems that a 3-egg clutch is the rule, and that 4 eggs may occur. The weights of three fresh and unblown eggs from Brood No. 4 were 6.2, 6.4 and 6.6 grams. In Brood No. 4 the eggs were laid daily.

Incubation.—Invariably I saw only one member of the pair incubating, almost certainly the female, which is also the rule among thrushes. I never observed it being fed on the nest by its mate. The nest in which I observed four broods was on the rafter directly under aluminum plates of a roof on which the sun shone during practically the whole of the day. Under these circumstances the temperature at the nest was extremely high and the incubating bird spent most of the time not sitting in the nest but crouching on it, panting with an open bill.

I was able to determine the incubation period only in Brood No. 4. The last egg was laid on May 3, when incubation started and all three eggs hatched on May 15, an incubation period of 12 days.

On March 25, 1952, when the bird was incubating Brood No. 3, a female Glossy Cowbird (*Molothrus bonariensis*) appeared and inspected the rafter with the nest. Its appearance caused a great tumult among the thrushes which chased it away, both of them dive-bombing the cowbird which disappeared as fast as it could. It was certainly only searching for nests of the House Wren (*Troglodytes musculus*) which is its usual host in Surinam and which regularly nests on rafters in the same situation as the thrushes. Other thrushes often took a bath in the gutter near the nest but when coming too near it they were chased away by both birds of the nest.

The nestling period.—The nestlings were fed by both parents and in practically all cases with unrecognized animal food. Once an unidentified berry

was brought to them. The excreta of the young were always taken away and dropped at some distance. I never saw them being swallowed. In the beginning of the nestling period the nestlings often were covered by the bird which had just fed them. The parent crouched over them exactly as during the incubation period. In Brood No. 4 this was seen for the last time on May 21, the nestlings then being seven days old.

When both parents arrived at the same time with food one of them waited in the neighborhood of the nest until the other had fed the nestlings. I never noted that one of the birds passed the food to the other or that both were at the nest at the same time. One of them—certainly the male—often arrived singing in flight while carrying food in its bill. The same bird often uttered a few strophes after having fed the young. Both parents customarily perched on a piece of wood near the nest before alighting on it, and also after feeding. It was on this perch that I observed on March 5, 1952, (Brood No. 2) an interesting behavior. After having fed the nestlings one of the birds alighted as usual on the piece of wood when suddenly its mate with food in its bill alighted near it. The first one took fright by the sudden appearance of its mate and took a threatening attitude, flashing both wings, a movement by which the rufous axillaries and under wing coverts became very conspicuous. It was exactly the same attitude described and figured by Dilger (1956. *Auk*, 73:324) as "double wing flashing" in *Catharus fuscescens*, but I did not note down whether this thrush tilted one of its feet in this attitude like *fuscescens*.

In only one case (Brood No. 4) was I able to determine the exact fledging period. The nestlings hatched on May 15 and left the nest after 17 days, on June 1. The nestlings having left the nest, were fed for some unknown period, probably by the male only, at least in the latter part of this period, for repairing of the nest for the next breeding cycle started in the same period. In Brood No. 2 the young left the nest on March 6, 7 and 8. Two of them were still being fed on March 15, whereas the repairing of the nest started on March 14.

Bathing.—Grey-headed Thrushes are very fond of bathing either by taking a shower bath in a tropical torrent or the usual bath while standing in a shallow pool of water. Sunbathing is also a regular habit in which the bird lies on its side on the ground with ruffled feathers and widely spread tail and widely open bill, one of its wings stretched to the utmost so that their underside is hit by the direct rays of the sun while it tilts over to the other side.

P.O. BOX 644, PARAMARIBO, SURINAM, DECEMBER 9, 1956

NOTES ON CERTAIN GROUSE OF THE PLEISTOCENE

BY ALEXANDER WETMORE

In the Ozark region of northwestern Arkansas in the spring of 1903, Mr. Waldo Conard, while searching for the site of an old lead mine, found a deposit of bones, some of which were sent to the American Museum of Natural History. Dr. Barnum Brown on behalf of that institution visited the area in the fall of 1903, and again in 1904, securing several hundred specimens. In his report (Brown, 1908) he identified 41 species of mammals, of which he named 19 as extinct species or subspecies new to science. Ten others were identified to genus or species, and in addition there was mention of amphibians, lizards, snakes and various bones of birds. Among the latter he listed the Turkey (*Meleagris gallopavo*) with a query. The location, near the northern boundary of Newton County, was on a hill at 1030 feet elevation, a mile north of the Buffalo River, 4 miles west of the settlement known as Willcockson, and 15 miles south of the town of Harrison in Boone County.

Some of the bird material later came to R. W. Shufeldt, who (1913, pp. 299–301) verified Brown's identification of the fragmentary material of the Turkey, and made additional rambling remarks under three headings, one marked "*Bonasa umbellus*?," and the other two headed "Bird (indetermined)," with reference under each to illustrations from photographs published in accompanying plates. The supposed grouse bones were allocated tentatively, as he stated that he had no skeleton material of the Ruffed Grouse available for comparison. In final comment (*loc. cit.*, p. 300) he said, "If subsequently found to be another species of either *Bonasa* or *Lagopus*, I would suggest the specific name of *ceres*." The records, except for the Turkey, have remained in this uncertain state until now.

Recently John E. Guilday of the Carnegie Museum, through Dr. Kenneth C. Parkes of that institution, has requested assistance in the identification of grouse bones from a Pleistocene deposit in western Pennsylvania. To provide this information it has been desirable to make a firm determination of the earlier Arkansas grouse material, since the bones from Pennsylvania were similar in size. The Arkansas specimens, in the American Museum of Natural History, have been made available to me through the kindness of Dr. Edwin H. Colbert and Mrs. Rachel H. Nichols. Shufeldt's material proves to represent an extinct species of Prairie Chicken, as indicated in the following allocation and discussion.

Tympanuchus ceres (Shufeldt)

Bonasa or *Lagopus* . . . . . *ceres* Shufeldt, Bull. Amer. Mus. Nat. Hist., vol. 32, art. 16, August 4, 1913, p. 300, Pl. 55, figs. 18–20, Pl. 56, figs. 45–72.

Pleistocene (Conard Fissure): Four miles west of Willcockson, and one mile north of Buffalo River, northern Newton County, Arkansas.

Type.—Amer. Mus. of Nat. Hist., Dept. of Vert. Paleo. no. 12392.

Characters.—Generally similar to the modern Lesser Paririe Chicken (*Tympanuchus pallidicinctus* [Ridgway]), but somewhat smaller; bill broader and somewhat stronger, as indicated by a fragmentary premaxilla; coracoid shorter but with shaft equally strong; scapula more slender; wing relatively smaller, as demonstrated by the individual elements as follows: humerus smaller, with head less bulbous, external condyle relatively smaller, entepicondyle slightly shorter, and opening for the pneumatic foramen a little smaller; ulna and radius definitely shorter, indicating a smaller middle segment of the wing; carpometacarpus slightly shorter and somewhat more slender; leg similar in length, but with the individual elements of femur, tibiotarsus and tarsometatarsus somewhat more slender.

Measurements.—Following are pertinent measurements of complete elements of the skeleton, with similar data from two male and two female skeletons of *Tympanuchus pallidicinctus* for comparison. The modern Heath Hen (*Tympanuchus cupido cupido*) and the Greater Prairie Chicken (*Tympanuchus cupido pinnatus* [Brewster]) are decidedly larger.

Total lengths	Tympanuchus ceres	Tympanuchus pallidicinctus
Coracoid	45.2	45.3–48.8
Humerus	59.7–60.5	61.2–67.5
Ulna	55.9–56.3	58.3–65.6
Radius	47.7–50.2	53.2–58.6
Carpometacarpus	33.1–34.7	34.7–41.0
Femur (approximate)	65.0–66.8	62.0–67.0
Tibiotarsus	85.5–87.2	80.3–89.8
Tarsometatarsus	44.9–45.4	42.8–47.2

Remarks.—A part of the sternum comprising the anterior end of the carina is too fragmentary to afford useful comparison. The scapula lacks the distal end of the blade. The greatest interest is found in the limb bones, as it is in these that the details attributed to specific difference are indicated. The wing elements have been described sufficiently above. In the leg the femur, represented by six specimens, all nearly complete, shows no differences from modern *Tympanuchus pallidicinctus* in form. The tibiotarsus has the condyles relatively smaller, but the measurements of total length, in the three specimens sufficiently complete to afford these data, fall within the limits shown by the two sexes of the living bird. The same is true in the total length of the two complete tarsometatarsi, but the fossil bones are more slender than those of the living species.

In summary, the skeletal elements indicate a bird slightly less in size than the modern Lesser Prairie Chicken, marked by heavier bill, and shorter, smaller wings, that stood about as tall as its living relative, but with more slender legs. It appears to have been of related origin with *T. pallidicinctus*, but not directly in the evolutionary line of that species.

Dr. Brown in his original account (1908, p. 159) located the Conard Fissure site as "four miles west of Willcockson." This is shown as a country settlement on the Harrison topographical sheet of 1905 of the U. S. Geological Survey, and is marked in some of the older atlases. It is not a post office, and is not found on newer maps.

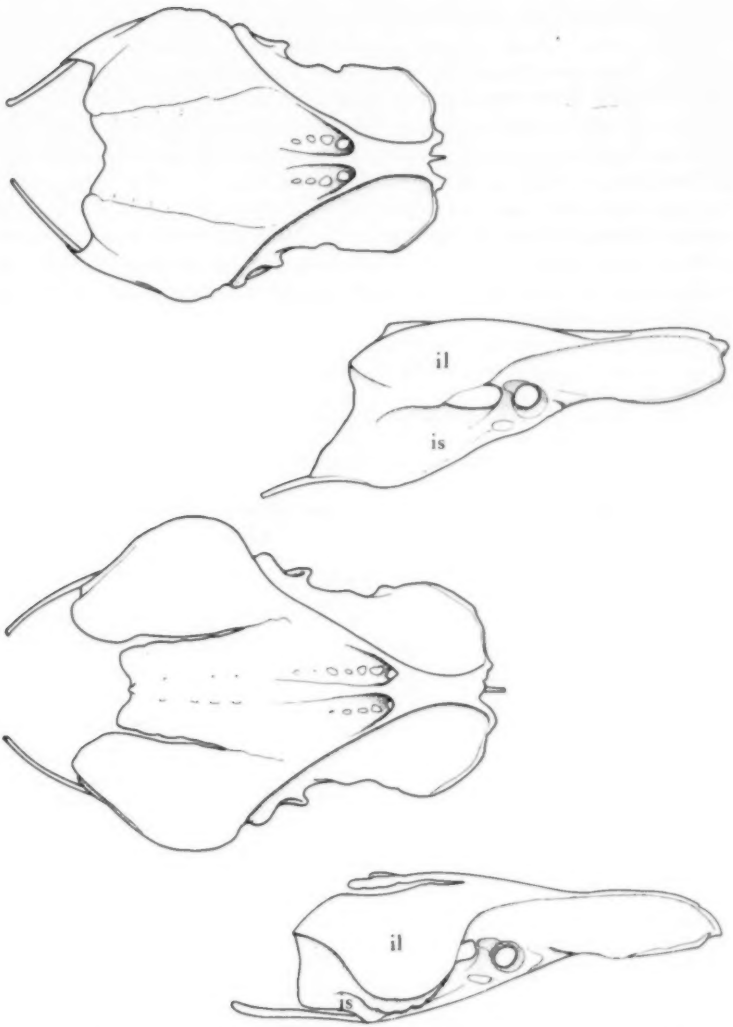
An important matter at the beginning of the examination of this Conard Fissure material was the determination of the characters found in the skeleton to separate the two currently accepted genera, *Tympanuchus* and *Pedioecetes*, since the general over-all appearance of the fossil placed it as a grouse of one of these two categories. I have had available in this study a series of 8 *Pedioecetes phasianellus columbianus* from Montana to represent that group, 4 *Tympanuchus pallidicinctus*, 2 of the recently extinct *Tympanuchus cupido cupido* from Massachusetts, and 3 *Tympanuchus c. pinnatus* from North Dakota. In life the modern species of *Tympanuchus* are marked by rounded tail, a prominent air sac bare of feathers on the sides of the neck (less evident in females), over which there is a tuft of elongated feathers in the male sex. *Pedioecetes phasianellus* has four central rectrices elongated to project prominently beyond the others, and lacks the bare area over the air sacs and the elongated neck feathers of the other group. Habitat and general habits are fairly similar in the two, and both gather in spring on display grounds where the males strut, posture and call. In detailed examination of the skeleton, element by element, beginning with the skull and continuing through sternum, pectoral girdle, wings, pelvis and posterior limb, I find that the only definite characters to separate the two groups of species appear in the pelvis. Details evident in other parts of the skeleton serve to identify species but are not valid to separate the two groups recognized as genera.

In *Pedioecetes phasianellus* the posterior section of the sacrum, viewed from above, is only slightly narrowed posteriorly, and remains in close contact with the ilium to the posterior border of the pelvis. Viewed from the side the posterior end of the ilium is produced as a point. From this same view the ischium below, and particularly behind, the ilio-ischiadic foramen is decidedly broadened. Overhang of the free border of the ilium over the foramen in question is slight. (See Figs. 1–2.)

In the forms of the genus *Tympanuchus* the posterior end of the sacrum, when viewed from above is narrowed, and does not extend to the end of the ilium (with or without an additional caudal element coalesced with it). Both internal and external angles of the posterior border of the ilium are rounded, and both, in this area, are free, the inner one from the posterior end of the sacrum, and the outer one from the projecting shaft of the pubis. Viewed from the side the ischium is narrowed, with the outer margin of the post-acetabular portion of the ilium projecting above it as a pronounced overhang. (See Figs. 3–4.) This projection is evident in both sexes but usually is broader in males.

There is enough of the sacrum preserved in the material of *ceres* to demonstrate that this species is a member of the genus *Tympanuchus*.

The specimen forwarded by Mr. John E. Guilday found in Lloyd's Rock Sinkhole, in the New Paris Sinkholes, one and one-half miles northeast of New Paris, Bedford County, Pennsylvania, collected September 21, 1958, is represented by all of the important parts of the skeleton. While these bones were in mixed association, they appear to come from one individual, since there is no duplication among them, and the paired elements represent right and



FIGS. 1–2. (*above*) Dorsal and lateral views of pelvis in the Sharp-tailed Grouse, *Pedioecetes phasianellus columbianus* (¾ natural size).

FIGS. 3–4. (*below*) Dorsal and lateral views of pelvis in the Greater Prairie Chicken, *Tympanuchus cupido pinnatus* (¾ natural size).

left sides. The pelvis (and the other bones) indicate clearly that the bird is the Sharp-tailed Grouse (*Pedioecetes phasianellus* [Linnaeus]), this being the first Pleistocene record for the species in eastern United States. Mr. Guilday interprets the considerable mammalian fauna with which the bird was found as a more boreal association than that of the present day in Bedford County. The presence of the grouse does not militate against this, as this species at present ranges north into northern Manitoba, northern Ontario, and Quebec. In modern times it has not been found in the United States east of northern Michigan. The fossil is believed to date back to late Wisconsin time.

There were a number of bones of the Ruffed Grouse (*Bonasa umbellus*) associated with the other species, affording another Pleistocene locality for this wide-ranging species.

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Smithsonian Institution, Washington 25, D. C., January 19, 1959

A PLEISTOCENE AVIFAUNA FROM ROCK SPRING, FLORIDA

BY GLEN E. WOOLFENDEN

ROCK SPRING issues from a limestone bluff approximately 6 miles north of Apopka, Orange County, Florida, in the north-central portion of section 15, T. 20 S., R. 28 E. The fossils here reported were taken from Rock Spring Run within 200 yards of the source. The bone-bearing, argillaceous sands represent an old channel fill overlying the Ocala limestone, which is exposed in portions of the stream bed. Lateral erosion of the sands exposes the fossils. The bones are well mineralized and most are not waterworn. The frequent occurrence in association of bones from what appear to be the same individual indicates that the material has not been reworked and that the bones are the same age as the matrix. Pleistocene age of the site is indicated by the presence of mastodon (*Mammut americanus*), horse (*Equus* sp.), tapir (*Tapirus veroensis*), peccary (*Platygonus* sp.), and camel (*Tanupolama mirifica*) in association with the bird material.

H. James Gut (1939) discovered the site; John Mann, Jack Todd and, particularly, Gerald Lintner obtained additional specimens. This report is based on all the avian elements the four collected. The material is now in the collection of Pierce Brodkorb at the University of Florida.

AVIFAUNA

The total number of bird bones available was approximately 1025, of which more than half were identifiable to species (Table 1). The 35 species and one additional genus determined make this locality one of the richer avian fossil deposits known. Four species are additions to the list of fossil birds of North America; four others are reported for the first time as fossils from Florida.

Gavia immer was known previously as a fossil in North America only from the Pleistocene of California, although Brodkorb (1953:214) refers to an ulna from Lake Monroe, Volusia County, Florida, as "near *immer*." Complete bones included in the 47 specimens from Rock Spring are three coracoids, two carpometacarpi, and one each of the following: humerus, ulna, radius, femur, and tibiotarsus. The major portion of a cranium is also present.

Among the 29 bones identified as *Ardea herodias* is an extremely large carpometacarpus 116.4 mm. in length. The length of the carpometacarpus in three *A. occidentalis* ranges from 96.4 to 100.9 mm.; in 33 *A. h. herodias* from 93.5 to 107.1 mm.; and in three *A. goliath* from 97.4 to 103.6 mm. (Adams, 1956 MS:70, 74, 75). The carpometacarpus in five *A. h. wardi* ranges from 108.0 to 113.0 mm. I can detect no qualitative differences between the fossil and *A. herodias*, and it seems likely that the fossil would fit within the range of a larger series of *A. h. wardi*.

In addition to the four elements assigned to *Nycticorax nycticorax* is the distal 20 mm. of a right tarsometatarsus that differs in several characters. The trochlea for digit 2 does not protrude as far medially and posteriorly, and the trochlea for digit 4 is extended

distally, thus the three trochleae appear more equal and parallel than in other herons; also the metatarsal facet lies closer to the trochleae. Measurements of the fossil are as follows: width of shaft distal to metatarsal facet, 6.3 mm.; width through condyles, 10.3 mm.; distance from distal end to center of metatarsal facet, 11.4 mm. This element, which was compared with all North American herons and some extralimital forms, may represent an additional species.

Ajaia ajaja was known previously as a fossil only from the Pleistocene of California. The Rock Spring deposit yielded the distal portion of a right tarsometatarsus.

Of the 1025 bird bones 620 were those of ducks. I was able to assign approximately half of these to eight species. *Aix sponsa* is recorded on the basis of a complete right humerus. Shufeldt's specimens of this species from Fossil Lake, Oregon, have been assigned to *Spatula* by Howard (1946:176). More recently, Pleistocene records of the species have been published for Ontario (Wetmore, 1958:9) and Kansas (Stettenheim, 1958:198). The Rock Spring specimen constitutes the first fossil record of this species from Florida.

Mergus serrator, hitherto known as a fossil only from Oregon, is the most abundant bird in the Rock Spring deposit. Maxillae, mandibles, portions of the syrinx, as well as whole specimens of all the long bones are present.

Aythya collaris was recorded from the Pleistocene of Crystal Springs, Florida, by Brodkorb (1956:158), but was published too late to be incorporated in the fossil checklist (Wetmore, 1956).

A method of separating the humeri of the Anatinae from those of the Aythyinae, based on certain characters of the pneumatic fossa, became apparent while working on the duck material from Rock Spring. In the Anatinae the fossa is deeper and partially excavates the medial bar. The construction is such that the palmar surface of the bar is not completely visible. Furthermore, the fossa usually possesses many bony struts. In the Aythyinae the pneumatic fossa is shallower, and the medial bar is essentially continuous with the shaft, exposing its palmar surface. Struts within the fossa are rare; in most cases the wall is solid. These characters enabled me to assign more than 100 specimens of river and diving ducks to their respective subfamilies; the specimens included several extralimital forms and all North American species with the exception of *Anas diazi*, *Bucephala islandica*, and *Camptorhynchus labradorium*. The humeri of two specimens of the Rosy-billed Pochard (*Metopiana peposaca*) of South America agree in all respects with those of the Anatinae. This deviation from what seems a reliable method of distinguishing the two subfamilies may be of phylogenetic significance, for Delacour and Mayr (1945:25–26) consider *Metopiana*, along with *Netta rufina* and *Aythya erythrophthalma*, to "constitute a bridge between the river ducks and the more specialized pochards of the genus *Aythya*. . . ."

Four bones in the collection belong to the order Charadriiformes. I was able to identify one of these to species and two to genus. A left tibiotarsus, lacking only the cnemial and rotular crests, is of *Limnodromus scolopaceus*. The element measures 60.0 mm. from distal condyles to proximal articulating surfaces. The same measurement taken from eight specimens of *L. scolopaceus* ranged from 55.4 to 65.4 mm.; seven specimens of

L. griseus vary from 52.2 to 55.7 mm. Although *L. griseus* has been reported from the Pleistocene of California, this is the first record of *L. scolopaceus* as a fossil.

The distal three-quarters of a left humerus and a fragment of the distal portion of a

TABLE 1

PLEISTOCENE BIRDS FROM ROCK SPRING, FLORIDA

Species	No. of bones	No. of individuals
Gavia immer. Common Loon	46	3
Podiceps auritus. Horned Grebe	1	1
Podilymbus podiceps. Pied-billed Grebe	18	4
Phalacrocorax auritus. Double-crested Cormorant	106	8
Anhinga anhinga. Anhinga	14	2
Ardea herodias. Great Blue Heron	29	3
Casmerodius albus. Common Egret	7	1
Nycticorax nycticorax. Black-crowned Night Heron	4	1
Botaurus lentiginosus. American Bittern	2	1
Ciconia maltha. extinct stork	2	1
Ajaia ajaja. Roseate Spoonbill	1	1
Anas fulvigula. Mottled Duck	2	1
Anas acuta. Pintail	1	1
Anas carolinensis. Green-winged Teal	4	2
Anas discors. Blue-winged Teal	4	2
Aix sponsa. Wood Duck	1	1
Aythya collaris. Ring-necked Duck	3	2
Aythya affinis. Lesser Scaup	55	15
Mergus serrator. Red-breasted Merganser	226	24
Coragyps atratus. Black Vulture	1	1
Buteo jamaicensis. Red-tailed Hawk	1	1
Haliaetus leucocephalus. Bald Eagle	2	1
Pandion haliaetus. Osprey	11	1
Meleagris gallopavo. Turkey	10	2
Grus canadensis. Sandhill Crane	6	2
Aramus guarauna. Limpkin	40	6
Gallinula chloropus. Common Gallinule	1	1
Fulica minor. extinct coot	1	1
Limnodromus scolopaceus. Long-billed Dowitcher	1	1
Larus sp. undetermined gull	2	1
Ectopistes migratorius. Passenger Pigeon	1	1
Strix varia. Barred Owl	2	1
Megaceryle alcyon. Belted Kingfisher	1	1
Dendrocopos borealis. Red-cockaded Woodpecker	1	1
Corvus ossifragus. Fish Crow	1	1
Richmondena cardinalis. Cardinal	1	1
Totals	609	98

left carpometacarpus are from a large gull, genus *Larus*. The fossil humerus shows minor differences from humeri of one *L. hyperboreus* and of two *L. marinus*, particularly in the region of the internal condyle and the entepicondyle. The fossil possibly represents an undescribed species. Its measurements are: greatest width of the distal condyles, 20.5 mm.; least width of the shaft, 9.0 mm.

The proximal portion of a left humerus of *Megaceryle alcyon* is the first fossil record of any member of the order Coraciiformes from North America. The bone agrees in all respects with that of the modern species.

Dendrocopos borealis, hitherto unrecorded as a fossil, is included on the basis of a partial left humerus. The genus *Dendrocopos* has been recorded from the Pleistocene of Carpenteria, California, by Miller and DeMay (1942:121, 68).

Four bones from Rock Spring are from passerine birds. Two were identified to species. *Richmondena cardinalis*, represented by a complete right carpometacarpus, was previously unknown as a fossil. *Corvus ossifragus*, represented by a fragmentary coracoid, is recorded from several other Pleistocene deposits in Florida.

Paleoecology

Most of the species from the Rock Spring deposit normally occur in riparian or aquatic situations. Certain of these, particularly *Podilymbus podiceps*, *Anhinga anhinga*, *Anas discors*, *Aix sponsa*, *Aramus guarauna*, and *Gallinula chloropus*, are generally inhabitants of fresh water. Three species of ectothermal vertebrates, *Rana catesbeiana*, *Chelydra* cf. *serpentina*, and *Alligator mississipiensis*, further substantiate a fresh-water environment at the time of deposition.

Together with the fresh-water species are three birds generally found on salt water in Florida. These are *Mergus serrator*, by far the most abundant species in the collection, *Gavia immer*, and *Podiceps auritus*. The occurrence together of species generally associated with salt water with those associated with fresh water suggests that the sea was nearer to the spring than at present.

The spring lies immediately east of the Pamlico shore line (MacNeil, 1950, map), and it seems likely that the bones were deposited during Pamlico or post-Pamlico time. The Pamlico shore line represents a rise of the sea some 25 to 35 feet above its present level. This rise in sea level probably made Rock Spring Run a sluggish depositing stream, possibly subjected to tidal flow.

Acknowledgments

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Department of Biology, University of Florida, Gainesville, Florida,
April 8, 1958

GENERAL NOTES

The behavior of two captive ostriches at a burning leaf pile.—Two ostriches in the collection of the New York Zoological Society at Bronx Park have shown great interest in piles of leaves burning in their enclosure each fall. The two birds are exhibited with cranes and antelope on a large, enclosed, rolling meadow called "The African Plains."

A typical instance, recorded by movie camera and observer during the fall of 1958, occurred on the 3.7-acre African Plains Exhibit: a keeper ignited a pile of leaves about three feet in diameter and then retired. As he left, the ostriches approached the fire, the female leading, and, after several short pauses when the birds watched the fire closely, the female lowered her head and walked into the smoke directly before the burning leaves. The male continued to stand off, perhaps 15 feet away, watching. Flames could be seen plainly among the leaves as the female preened her neck, raised folded wings (over her back), and lowered herself on her tarsi. The bird's breast extended over the edge of the burning pile and smoke engulfed the forepart of her body. Glowing ashes and small flames were still visible very close to the bird. She kept her wings raised but waved them regularly in short movements over the back. The body plumage was moderately raised. Finally the bird lowered herself to her breast, protruding well into the smoking edges of the leaf pile, and continued to wave her wings. The neck was not extended nor was the mouth obviously open. When the female arose she preened her neck briefly and walked away from the smoking heap. The male approached her and began courtship display, eventually chasing her to the far end of the enclosure.

The female performs most often at the burning leaf piles, though keepers report that the male indulges in exactly the same activity. I have not observed the male at the fire. While these performances have not been timed and the character of the fire has varied from time to time, the ostriches rarely spend more than two or three minutes at the leaf pile. Frequent keeper observations confirm that the male often displays to and chases the female when she arises from the leaf pile. Crowned Cranes and a European Crane in the same enclosure have not been observed at the leaf piles. The female ostrich (*Struthio camelus australis* Gurney) was received as an adult in 1947. The male (*S. c. massaicus* Neumann) was acquired as a half-grown bird in 1955.

The motivation and degree of relationship of this behavior to anting, bathing, sunning, dusting or even smoke bathing is difficult to delineate. Smoke bathing as described by Ridley (1948. *Brit. Birds*, 41:83) for Jackdaws, White (1948. *Brit. Birds*, 41:244) for Herring Gulls, and Stevens (1948. *Brit. Birds*, 41:244) for the Black-headed Gull, for example, does not appear to be entirely of the same nature though it certainly may be related. Of course, the ostrich is a specialized form and differences in behavior may be expected. Ambient temperatures (fall) were usually low when the birds performed at the fire, but the female has performed on quite warm days. The birds' attitude and movement at the fire is somewhat reminiscent of dust bathing with wing movements, perhaps, inhibited by the fire. It might be that anticipatory dust bathing is implied in the short wing movements. In this connection, however, the birds have not been seen dusting in unburned leaf piles, or ashes from burned piles, and not even in warm ash piles. Actual visible flame has been present, in most cases, when the birds have become interested in the heaps. Furthermore, the action of the female seems the result of strong motivation, for she may be counted upon to perform with fair regularity despite the presence of observers in places where the birds are not used to seeing visitors. We seldom see normal dusting in these two captive birds. Such dust bathing as I have noted in other specimens and would expect to be normal, resembled the dusting behavior of gallinaceous birds such as quail. Ostriches and rheas may get down in scrapes in sand or earth, work themselves

over on one side, rub their necks upon the ground and throw, with their wings, considerable material over their backs and through the plumage. This sort of dusting is an activity easily inhibited by the presence of observers.

We cannot eliminate the learning factor in captive birds, or, for that matter, in wild birds, and the possibility remains that the lack of some natural element in the birds' wild environs may have provided a drive leading to artificial behavior. However, this possibility does not provide an explanation for the observed behavior.

The movement, posture and general attitude of the ostrich's activity do not suggest rigid stereotypy or the "ecstasy" reported in some birds during anting and sunning. Whitaker (1957. *Wilson Bull.*, 69:195–262) lists heat or the "thermogenic" element as "a probable factor in most anting situations," and Lanyon's (1958. *Wilson Bull.*, 70:280) observations on meadowlarks seem to establish heat rather than light as the major factor in the sunning behavior of this species. We believe heat to be a major factor in the ostriches' behavior, though their actions at the leaf pile did not resemble either of the two postures we have usually associated with ostrich sunning, and we know of no "anting" reports for ostriches. Ostriches, when sunning, may be seen standing with mouth partly open, plumage raised and wings slightly extended, or, occasionally, we see a bird resting upon its breast with wings partially extended on the ground and the head and neck folded over the back.

The leaf pile activities of the ostriches do not conform with examples in Whitaker's (*Ibid.*) anting compilation or with such anting behavior we have noted, either in an "active" or a "passive" sense.

Of course, the limits of behavior termed anting, bathing, dusting, or sunning are arbitrary at best. Chisholm (quoted by Whitaker) summed it up nicely: "Smoke-bathing may in fact be complementary to water-bathing, sun-bathing and dust-bathing, and all four may well be allied to 'anting' with acids." The Zoo Curator, working day-in and day-out with live birds, has great opportunity to watch bathing, sunning and even anting activities in many diverse species, and soon may tend to think of these behavior patterns as points on a continuum. For example, we may suggest a very close connection between anting and sunning and, perhaps, we may think of these activities as the same basic response varied by position and focus of stimulus. Thus "active" anting may be a response to an extremely localized "thermogenic" stimulus, while sunning, involving, as Lanyon (*Ibid.*) says: "sudden warming of the bird's immediate environment," may be a more general reaction to a more diffuse heat source. Thus, a bird ants with a hot match stick but suns to hot air. Between these two peaks of behavior, but within the same range, may we not also situate passive anting involving postures and reactions intermediate between sunning and anting with modifications perhaps dependent upon the moderately localized stimuli of numbers of ants rather than the focused stimulus of a single ant or wad of ants. Furthermore, those who have watched a diverse collection of captive birds will be familiar with the similarity of bathing and dust-bathing in a number of transitional forms. Many will have observed certain birds of prey and pigeons assuming the same postures during rainfall as during sunning and noted that dusting is most frequently associated with a heat factor. At the Zoo we find our quail and pheasants dusting in the sunny parts of their cages, in places changing with the movement of the sun where there is heat. We have observed birds dusting on ant hills and in warm oily soil, all of which provide connecting links in the chain of relationships of these behavior patterns. This general synthesis presents a problem for study long overdue.—William G. Conway, *New York Zoological Society, New York 60, New York, January 21, 1959.*

Strife over a nesting site between Downy and Red-headed Woodpeckers.—On April 24, 1956, a pair of Downy Woodpeckers (*Dendrocopos pubescens*) began construction of a nest approximately 20 feet from ground level in a dead lombardy poplar in a woodlot in St. Paul, Minnesota. The woodlot, some 4.5 acres in extent, is composed primarily of boxelder (*Acer Negundo*) and lombardy poplar (*Populus niger* var. *italica*) with an understory of gooseberry (*Ribes* sp.), honeysuckle (*Lonicera* sp.) and common lilac (*Syringa vulgaris*). The nest was successfully established and was occupied until May 18.

On that date, at 2:30 p.m., a Red-headed Woodpecker (*Melanerpes erythrocephalus*) was first observed in the woodlot. This woodpecker flew to a poplar tree about 10 feet from the Downy Woodpeckers' nest. It was immediately harassed by both Downys which flew close by in sweeping dives, emitting loud, scolding cries as they approached within four or five feet of the Red-headed Woodpecker. After several minutes of this fluttering, during which time the latter remained stationary, the Downys flew to nearby trees. One perched on either side of the *Melanerpes*, but not between it and the nest. The Downys shook their heads vigorously in an up-and-down motion in the direction of the intruder and continued their loud cries. The Red-headed Woodpecker seemed to ignore their defensive behavior and flew to the nest entrance. It began to enlarge the entrance hole immediately, and, after several minutes, could place its head and shoulders within. At this point the owners' display increased in intensity. They flew at the intruder with their fluttering dives, approaching more closely until they were diving to within six inches of their adversary. After several of these close dives, the Red-headed Woodpecker would leave the nest entrance momentarily and fly directly at the Downys. The latter would fly away at its approach, and were chased until they were 20 to 30 feet from the nest tree. The intruder would then return to the nest entrance and continue the enlarging process. The Downys came back to within 10 feet of the nest tree, and resumed their fluttering dives, gradually working closer until they were again diving to within six inches of their adversary. At this point the intruder drove them away from the nest tree again and the entire process was repeated. This procedure took place four or five times from 2:30 p.m. to 3:50 p.m., at which time the Red-headed Woodpecker discontinued enlarging the entrance to the nest and flew out of sight toward the east.

Immediately upon departure of the Red-head, the male Downy returned to the nest. He appeared very cautious, and several times partially entered the nest before finally going inside. He then cleaned the nest of the debris caused by the enlarging processes. During this time his mate sat in a tree about three feet from the nest.

After a period of about 10 minutes, the Red-headed Woodpecker returned to the nest. As he approached, the male Downy left the nest, possibly warned by his mate which emitted the chirping cry when their adversary came into view, and the entire process as outlined above was repeated. After approximately one-half hour of work on the nest entrance, during which the Downys were driven away several times, the Red-head again voluntarily left the nest, and flew directly to an oak tree approximately 400 feet east of the Downy Woodpeckers' nest. It was met at the oak tree by its mate, which had not been noticed previously. Both then flew to the Downy Woodpeckers' nest.

During the Red-head's absence, the male Downy Woodpecker had again cleaned the debris from the nest. However, at 4:45 p.m., when both male and female Red-headed Woodpeckers returned to the nest, the Downys left the area without an attempt to drive the intruders from the nest, and were not seen near the nest thereafter.

It is not known if the Downys had a clutch of eggs in the nest, but their long period of tenancy indicates that they probably were in the process of incubation. The Red-

headed Woodpeckers were still in possession of the nest during the first week in June when observations in the woodlot were terminated.

A Downy Woodpecker nest, newly constructed, was found on May 24, approximately 450 feet from the other Downy nest. Since Downy Woodpeckers were not noticed using the woodlot previously, it is believed that this was a re-nesting attempt by the pair ousted by the Red-headed Woodpeckers.—R. G. Schwab and J. B. Monnie, *Department of Entomology and Economic Zoology, University of Minnesota, St. Paul 1, Minnesota, June 24, 1958.*

Pilot black snake and nesting Pileated Woodpeckers.—In May, 1957, I observed a pilot black snake (*Elaphe obsoleta*) which remained close to the nest of a pair of Pileated Woodpeckers (*Dryocopus pileatus*) over a period of five days. The nest was 40 feet from the ground in a dead stump in a swamp, near Seneca, Maryland, and contained small young, as judged by the behavior of the parents and the *chrr* notes which attended their visits.

Pilot black snakes are effective predators of nestling birds. This fact may be illustrated by the following examples: 1) On June 15, 1952, I killed one of these snakes as it was leaving the nest of a Catbird (*Dumetella carolinensis*). The snake's stomach contained four well-feathered young catbirds. 2) Hoyt (1957, *Ecology*, 38: 246–256) cites the experience of Rhein, who took films of a pilot black snake as it climbed a tree trunk and entered the nest of a Pileated Woodpecker, from which it was later removed in the act of swallowing the well-developed young. Having seen Rhein's film, I was startled on May 18 to discover that a 5-foot black snake was at a level with the nest of the Pileated Woodpeckers. The snake disappeared into a crevice behind and above the nest entrance. When its head reappeared in a small hole 10 minutes later, the male woodpecker also had its head out, directly below that of the snake. The two heads were about three feet apart. I now heard *cuk, cuk*'s as the female Pileated Woodpecker alighted on a nearby tree, flew to the entrance, and then entered after her mate flew out. The snake withdrew from sight during this change-over. Two inches of its head and neck emerged from the same hole 15 minutes later, but the female woodpecker remained out of sight.

I watched the nest hole for 30 minutes on May 19. The snake put its head out the small hole for a few minutes during this time. My next visit was on May 23. The sun was coming out after three days of cold, wet weather, and the pilot black snake was partly stretched on a broken limb where I had first seen it on May 18. On May 23 the male woodpecker had his head and neck well out as if trying to see the snake a foot away and around the curvature of the stump. Neither animal appeared to be excited. The snake moved with great slowness, taking 28 minutes to descend to the ground where it disappeared in the vegetation before I could catch it. Subsequent observations indicated that the Pileated Woodpeckers were successful in raising their young.

It was not apparent that the snake could have entered the nest hole of the Pileated Woodpecker. One or the other of the parent birds was always inside. This continuous attendance on small young is, in my experience, common to other species of woodpeckers. The situation is different when the young are more developed. Parent birds then spend more time collecting food and, in the case of Pileated Woodpeckers, the nest may be visited only at intervals of 30 to 60 minutes. The pilot black snake might be more dangerous at this later period which was, I believe, the one photographed by Rhein. One can only conjecture why the snake was in the stump. It may have been laying eggs, or simply resting over a period of cold weather without primary interest in the young Pileated Woodpeckers stirring within their nest a few feet away.—Lawrence Kilham, *7815 Aberdeen Road, Bethesda, Maryland, January 14, 1959.*

The plight of the bluebird in Michigan.—The plight of the Eastern Bluebird (*Sialia sialis*) over much of its range in eastern United States is rapidly becoming a matter of record (see *Audubon Field Notes*, Vol. 12, Nos. 3 to 6, 1958). To this I wish to append my meager Michigan data for the spring, summer, and fall of 1958.

In April and May several people called me to ask what had happened to the bluebirds. People who had had bluebird tenants for many years had none this spring. A check of my own records showed that up to May 24 I had no Ingham County observations of this species; my only notebook entry was of a bird heard "warbling," but not seen, on April 19, about 10 miles north of St. Johns in Clinton County.

On May 24 six students and I took our annual May-day count in which we cover, in marathon fashion, all of the better known local birding spots. Increasingly conscious of the difficulty we might have in adding the bluebird to our list we covered many miles of promising habitat before getting our first and only record along a back road west of Lansing. Another segment of our searching party also located one bluebird. This west Lansing bird proved to be my only Ingham County record for 1958, but Mrs. Walter Halliday, who had been checking all spring on the disappearance of bluebirds from their former Okemos nesting sites, reported that she had finally located an occupied nesting box and that it produced young. Other local observers reported similar experiences, i.e., few or no bluebirds. Only four spring records were turned in for the Michigan Audubon Society's Bird Survey report.

During the summer session at our Gull Lake Biological Station I had difficulty finding bluebirds anywhere in the several counties covered on field trips. On June 28 I spotted one on a telephone wire on M-89 near Augusta (Kalamazoo County), but was not able to relocate it on several subsequent visits to that area. On July 25, however, we found a pair along a back road in Allegan County, near Fennville.

In September Mrs. Wallace and I took a 12-day trip into the eastern part of the Upper Peninsula. Though well aware by then of the state-wide scarcity of bluebirds, I had some expectations of finding them assembling on roadside wires, as is their custom at that time of year. Our first two bluebirds were encountered on September 8 near Wolverine, 204 miles (by my odometer) north of East Lansing. Our next record was 10 days and approximately 1,000 miles later, when we located a group of six birds along a gravel road near Moran in Mackinac County. In six days of observations on fall migration at Whitefish Point, Chippewa County, where we recorded 77 species of birds between September 11 and 17, we did not see or hear a single bluebird. We also made a cursory check of the Gould City area (Mackinac County), where Dr. Karl Christofferson told us he had formerly seen large flocks (up to 75 in one count) in September and October. We found none in about 10 miles of slow driving (with frequent stops to look and listen) along back roads. At his station in Blaney Park, Dr. Christofferson had one pair of nesting bluebirds this summer in the 60 boxes he has provided for birds.

Our only other bluebird record on this 1,668-mile trip, mostly in ostensibly favorable bluebird country, was of two birds perched on wires along U.S. 27 near Otsego Lake on September 19—a total of 10 birds in three places in 12 days of observations. By contrast we counted 31 Sparrow Hawks (*Falco sparverius*) in about 15 different places (average of two per locality), mostly along roadside wires, as the bluebirds should have been.

Some of the reasons for the decline of the Eastern Bluebird over much of its former range are not hard to assess. It suffers from competition with more aggressive hole-nesting species, such as the Starling (*Sturnus vulgaris*) and the House Sparrow (*Passer domesticus*). Even native birds, such as Tree Swallows (*Iridoprocne bicolor*) and House Wrens (*Troglodytes aedon*), often win out in conflicts with bluebirds (Batts, 1958. *Jack-pine Warbler*, 36:138). Bluebirds are also subject to severe climatic changes—the un-

precedented winter of 1958 will go down in history as a disaster of major proportions for bluebirds and other insectivorous species that winter in the southern states. Many people suspect insecticides, but the evidence for this rests largely in the disappearance of the species from modern orchards, croplands, and roadsides in settled areas. Some bluebirds are showing up among the many victims of the ill-conceived fire-ant control program in the southeast; completion of the projected program, which comprises a large part of the Eastern Bluebird's winter range, might well write the finish of this once familiar and much beloved bird. Perhaps the key to the whole problem lies in the widespread loss of favorable habitat, from all causes. In Michigan, at least, the bluebird now seems to be largely restricted to the jack-pine areas of northern counties and the more remote, abandoned or uncultivated farmlands.—GEORGE J. WALLACE, *Department of Zoology, Michigan State University, East Lansing, Michigan, January 17, 1959.*

The poisoning of meadowlarks with insecticides.—On March 6, 1958, Everett Woods, graduate student in the Department of Entomology, informed Dr. F. M. Baumgartner and me that meadowlarks were digging and eating freshly planted oat and barley seeds on a test plot at the Small Grains Laboratory. We thought it a good opportunity to test some candidate chemical bird repellents, so I went immediately to observe the plots. Twenty meadowlarks were feeding on the plots at that time. Closer observation on that date and on subsequent days revealed that the birds started by picking up scattered grain on top of the ground, digging up large pockets of grain where the planter had stopped at the end of the rows, and then starting down the rows digging up the seeds as they went. We made plans to spray the area with repellents, but adverse weather conditions all during March prevented us from doing it.

The following day, seven dead Eastern and Western Meadowlarks (*Sturnella magna* and *S. neglecta*) and a very sick one were found near the plots. A quick check revealed that the seed of each of two plots, four rows 10 feet long, had been treated with ¼ lb. to ½ lb. of Di-Syston and ¼ lb. to ½ lb. of Thimet per 100 lb. of seed, respectively. These two insecticides have an accumulative effect and are highly toxic to vertebrates. The sick bird appeared to recover fully and gain weight while being kept caged in my office. Its reactions seemed to have become normal as it soon became a pet and learned many tricks very quickly. About two months later, it suddenly quit eating and drinking and within a few days died.

Observations were continued on the plots until March 30, 1958. The meadowlarks continued to dig seed in some of the plots, and although large feeding areas and roosts were thoroughly searched, no other dead birds were found. These observations further point out the serious effects that some insecticides have on birds (Dewitt, 1957. *So. Car. Wildlife*, Fall). Indications are that unless extreme care is used when applying these chemicals very high bird mortality can be expected.—DAUDE N. GRIFFIN, *Department of Zoology, Oklahoma State University, Stillwater, Oklahoma, January 7, 1959.*

Blue Jay feeding on termites.—One day during the last week of June, 1957, a Blue Jay (*Cyanocitta cristata*) flew down directly from its perch in a tree near by to feed on a mass of winged termites concentrated on the top of an old stump in the front lawn of our house at Greenbelt, Prince George's County, Maryland. It pecked avidly at these insects for about two minutes, leaving the site only when someone went to the stump to apply insecticide. The insects were identified as *Reticulitermes virginicus* by Dr. Thomas E. Snyder of the U. S. National Museum, Washington, D. C.

The relatively few sight observations of birds eating termites, summarized by Blake (1941. *Auk*, 58:104) and Cowan (1942. *Auk*, 59:451), do not include the Blue Jay.—DONALD H. LAMORE, *Department of Biology, Cottey College, Nevada, Missouri, August 13, 1958.*

A late record for Northern Phalarope in West Virginia.—On November 23, 1958, Gordon Knight, John L. Smith and I were searching for waterfowl on Lake Lynn of the Cheat River, Monongalia County, West Virginia, when our attention was drawn to a small bird swimming about 50 feet offshore. The bird was studied carefully for about 15 minutes with both 7× binoculars and a 30× telescope, and proved to be a Northern Phalarope (*Lobipes lobatus*). Mr. Knight and Mr. Smith were not previously acquainted with this species in life and were unfamiliar with the characters separating the three phalarope species. Accordingly, I questioned them carefully as to what they were seeing. It was agreed that the bird had the striped upper back and the thin, black bill of this species. The bird appeared to be in good condition and was feeding in the typical phalarope manner. It is of interest to note that there had been no pronounced atmospheric disturbance to bring this unusual bird to our region. It was not possible to collect the bird at the time, and when I returned on November 26 to attempt to collect it, I was unable to locate it.

There are very few previous records for this species from West Virginia. The U.S. Fish and Wildlife Service has a record from Parkersburg, Wood County, on September 26, 1888 (C. S. Robbins *in litt.*). G. Eifrig collected one on the Potomac River in Mineral County on May 23, 1901 (1902. *Auk*, 29:76). Bibbee (1934. *W. Va. Agric. Exp. Sta. Bull.* no. 258) lists two collected at Parkersburg in "the late fall" of 1922. I have found no further records and thus it appears that this is the first record for the state in the past 36 years, and is the first record for this part of the state.

Mr. Chandler Robbins has kindly furnished me with information pertaining to late dates for this species from the Fish and Wildlife Service files. The only other inland record approaching this one in lateness is apparently one from Milwaukee, Wisconsin, on November 5, 1949. Along the Atlantic Coast there are about seven records for November, three for December, and two for February. I am unable to locate any Ohio, Pennsylvania, or Maryland dates that approach this one in lateness.—GEORGE A. HALL, *West Virginia University, Morgantown, West Virginia, March 2, 1959.*

Observations at a Goshawk Nest in Northwestern Montana.—My banding station, at Sun Camp Ranger Cabin, was on the shores of St. Mary Lake, which is part of the Hudson Bay drainage system on the east side of the Continental Divide. The lake is surrounded by peaks of the Lewis Range of the Rocky Mountains in Glacier National Park, Glacier County, Montana. The latitude of 4839 is used on banding records for this Sun Point Area. The old log ranger cabin is in the forest of the Spruce–fir Zone, the Engelmann spruce–subalpine fir association of Daubenmire (1943:334–337), at 4500 feet elevation, and can be reached only by trail or boat.

In mid-July, 1956, I saw a Goshawk (*Accipiter gentilis*) darting through the tree-tops near our cabin. At intervals the call-note of *kak kak kak* was repeated. I soon discovered the cause of these staccato cries. The hawk's nest was well hidden about 60 feet up in a fork of an Engelmann spruce located only 50 feet back of our cabin along the bank of Baring Creek. The stream emerges from a canyon, drops down as Baring Falls nearby, and flows into St. Mary Lake.

Bailey (1918:147) reports sighting one Goshawk in the Many Glacier Area, and one was seen by H. C. Bryant in upper St. Mary Valley. Both areas are on the east slope of the Continental Divide and have the same type of forest habitat as St. Mary Lake. Dumas (1950:234) found the Western Goshawk in the Mixed Forest of the Montane Forest Area in S.E. Washington. Snyder (1950:23), in a study in the Rocky Mountains east of the Continental Divide in Boulder County, Colorado, found the Goshawk to be a permanent resi-

dent in the Rocky Mountain Coniferous Forest. Although Glacier is farther north than these studies, the type of forest habitat is similar. Here a tree-shaded habitat near water was selected by the nesting Goshawks. The Goshawk is found in boreal forests, generally on slopes of canyons not far from water, according to Bent (1937:139–140).

I am indebted to my son, Monty, who climbed the difficult tree regularly to make close-up observations and pictures of the birds. The nest measured 3 feet long, 2½ feet wide, and 2 feet deep. It was composed of sticks and green alpine fir branchlets which were rather loosely put together. It was lined with fir foliage and some feathers. It appeared almost flat, with only a shallow depression on the top.

The first close-up observation on July 24 revealed four young Goshawks in downy coats of silky white. The number of eggs and young was three in California Goshawk studies by Dixon (1938:5) and Ingles (1945:215). Bent (1937:128) found that the Goshawk ordinarily lays three or four eggs.

On August 5 Monty climbed the tree to band the young, but as he reached the nest all four young hopped out and fluttered down to smaller trees, hanging upside down from small branches clutched firmly in their talons. However, one young bird was strong enough to fly to the top of a nearby black cottonwood. We successfully retrieved three of the young birds but could not reach the one in the tree-top.

We photographed and banded the three young birds. Although the birds snapped their beaks they did not bite. One of the young was a runt, noticeably smaller than the others. They tried to stay out of the hot sun by moving into shaded areas. Monty then took the birds in a sack and safely returned them to the nest. As he started down he had to ward off an adult Goshawk by hitting it with his tin hat. Other observers have suffered gashes and torn clothing (Rowley, 1939:247; Dixon, 1938:4), or have been struck while walking along a trail near a nesting site (Jewett, 1953:162). The young Goshawk in the tree-top returned to perch above and near the nest but did not return to the nest, although the adults fed it near the nest.

My first week of observation was that of July 22 when the young downy Goshawks were rather quiet and inactive in the nest. During the second week, that of July 29, we had observed some fighting over food and heard much peeping sounding like baby chicks. The birds at this time arranged themselves around the outside portions of the nest.

We had banded the young birds at the beginning of the third week, August 5, and from nest observations and the juvenal plumage estimated the age of the birds to be two weeks plus. During this third week the young birds exercised daily by stretching and flapping their wings. Dixon (1948:7) found that much time was spent by the young in preening and exercising by flopping back and forth on the nest. We saw the birds take many short floppy flights from limb to limb. They tore off meat with their beaks while holding the prey with their talons. Then they sat on the edge of the nest to complete the swallowing of large chunks of meat. They regurgitated the hair and feathers of animals in pellets very similar to those of owls.

The next day after banding the young birds, August 6, an adult Goshawk "shadowed" me as I walked along the trail from the cabin through the forest. Flying from tree-top to tree-top the Goshawk uttered screams of a plaintive nature sounding like *kew kew kew*. This was probably a reaction to the disturbance of our banding activities.

The fourth week, beginning August 12, found three of the young in full juvenal plumage, but the runt remained concealed in the nest. Three of the birds were very active now and took small flights out among tree branches. Their wings were noticeably larger and they practiced maneuvering the long tail. The adults were now kept busy feeding individual young birds. They always greeted the adult with chirps which were totally out of keeping with their large size and ferocious appearance. Two birds sometimes playfully touched beaks. They no longer fought over food but ate one at a time, pulling meat apart and swallowing at the same time. The down on their legs gave the appearance of pantaloons and they acted like clumsy adolescents.

We identified, from remains of their food, a chipmunk and a golden-mantled ground squirrel. Most of their food was small mammals of this type, although a few remains of birds were found. Both Dixon (1938:9) and Ingles (1945:215) found that the food brought to the nestlings of the Goshawk was almost entirely mammals. That part of the food was wasted was indicated by the remains we picked up under the nest-tree. Sprunt (1955:45) found from stomach studies that the Goshawk eats primarily birds, but about 30% was various rodents. In our observations it seemed to be the relative abundance that caused the larger proportion of the prey to be rodents. In Glacier other birds complete their nesting early in the season, largely before the hatching of the Goshawks.

Although a bulky structure over two feet in diameter the nest had been slowly falling apart under the vigorous activities of the Goshawks. We had noted some disintegration of the nest on August 5. By August 14 only about 1/3 of the nest remained and only the runt remained in the nest. However, the young birds remained close to the nest-tree. One young bird was perched in a large cottonwood across the creek. All were calling with a loud, clear "peeping" call as they did when food was brought, in contrast to the urgent piercing call when hungry. Later the young Goshawk perched in the tree clutching a chipmunk in its talons.

On the morning of August 15 the nest had fallen apart completely and we found sections of it on the ground. The young birds were perched on and near the nest-tree.

After this the adult Goshawks fed the young by coming in rapidly to the nest-tree and dropping the dead prey, usually chipmunks. This occurred at low heights in the tree and the juveniles had to catch the falling prey, and often fought over it. This may be a method of teaching the young how to catch prey. If the prey was not caught by the juvenile hawks

it was never retrieved by the adults. The runt remained at the nest-site calling endlessly for food. The runt could not compete for food with the others with this type of feeding since it was small and had a defective leg.

On August 19 the runt of the nest flew down on the roof of the cabin several times and then would return to the nest-tree. About noon it was hanging upside down from a branch and then fell to the ground with its eyes closed. In a few minutes it was dead, probably from starvation.

For the next week we heard the birds calling nearby in the forest but they no longer returned to the nest-tree. The young birds had full juvenal plumage and resembled the adults except for down on the belly. Then we did not hear the birds after August 24 when the three juveniles were seen together calling excitedly as they did when one bird had food.

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ORNITHOLOGICAL NEWS

We are happy to announce that Roger Tory Peterson has become a Patron of The Wilson Ornithological Society.

It is a pleasure to announce that Olin Sewall Pettingill, Jr., will act as review editor for the Ornithological Literature section of *The Wilson Bulletin*. All items intended for review should be sent to Dr. Pettingill at Wayne, Maine.

The Forty-first Annual Meeting of the Wilson Ornithological Society will be held in Gatlinburg, Tennessee, May 5–8, 1960. The Huff House of the Mountain View Hotel will be the headquarters.

On April 11, Mr. W. E. Clyde Todd marked his **sixtieth** anniversary at Carnegie Museum. He attained the status of Curator Emeritus in 1945, and in 1957 was appointed Honorary Curator of Oölogy in connection with the acquisition by Carnegie Museum of the egg collection of the late Herbert Brandt.

Mr. Todd became a member of the Wilson Ornithological Society in 1911 (only five current members joined the Society earlier than this).

Professor V. C. Wynne-Edwards, on leave from Aberdeen, Scotland, is currently occupying the Tom Wallace Chair of Conservation in the biology department at the University of Louisville.

About 20,000 specimens of bird and mammal stomach contents remaining in the Fish and Wildlife Service's Patuxent Research Refuge Food Habits Collection (after the recent distribution of specimens of immediate research interest to over 100 qualified research workers) have been transferred to the Department of Zoology, University of Massachusetts, Amherst, Massachusetts.

The specimens remaining will be available after February, 1960, to qualified research personnel for specific food habits studies. Address inquiries to Dr. L. M. Bartlett, Associate Professor of Zoology, Department of Zoology, University of Massachusetts, Amherst, Massachusetts.

Request for Information

In some species of animals having two or more distinct color phases, non-random mating occurs. I should like to investigate the possibility that this sort of preferential mating occurs in certain species of North American birds with two color phases. The question can be answered best by an analysis of records of a large sample of breeding pairs. Therefore I am soliciting any records of the color phases of breeding pairs of the following species: Screech Owl (*Otus asio*), red and gray forms; Ferruginous Hawk (*Buteo regalis*), dark and light forms; western Red-tailed Hawk (*Buteo jamaicensis calurus*), dark and light forms. Instances of birds of intermediate coloration would also be valuable. For the purpose of this inquiry, I need records of definitely mated pairs, no matter whether the members of the pair are the same or different in coloration. I can supply fuller details to anyone interested in participating in this work.—*D. F. Owen, Department of Zoology, University of Michigan, Ann Arbor, Michigan.*

Note

From Daniel McKinley:

For an improved version of my "Early record for the Ivory-billed Woodpecker in Kentucky" (1958. *Wilson Bull.*, 70:380–381), see "An early record and description of the Ivory-billed Woodpecker in Kentucky" by Dr. A. W. Schorger (1949. *Ibid.*, 61:235). I offer professional apologies to Dr. Schorger; to Drs. Dixon and Tanner, I can only say that no harm was meant.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

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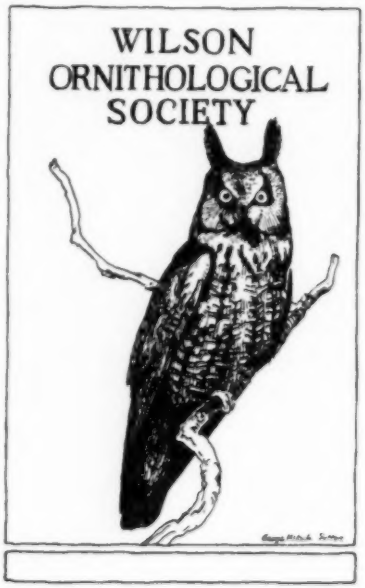

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H. LEWIS BATTS, JR.
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Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the printer of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated in the mailing list and there is a printer's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He will notify the printer and editor.

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